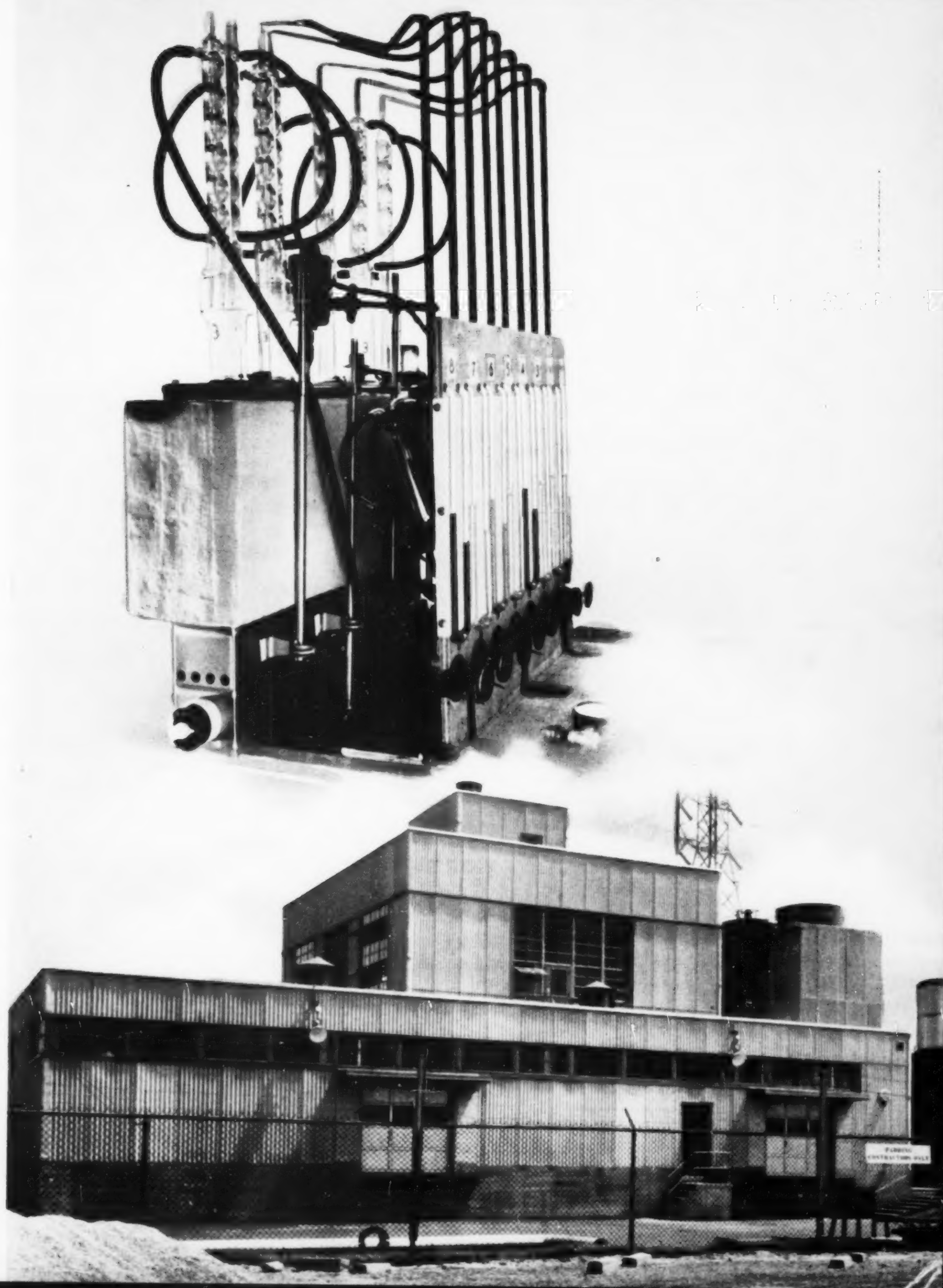
NLGI Spokesman

Journal of National Lubricating Grease Institute



Three-Part Harmony

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President's page

by W. Wayne Albright, President, N L G I

THREE-PART HARMONY

Part one of the harmony is development of multi-purpose lubricating greases, part two is uniformity of grease packages, and part three is coordination of grease dispensing equipment.

LUBRICATING GREASE MANUFACTURING

The history of greasemaking has been one of development of better greases, specialized lubricating greases specifically designed to handle certain necessary requirements. In the process, new greases were developed with such unusually good properties that they were found capable of application to a wide range of lubricating requirements. Now the trend is definitely toward the multi-purpose lubricating greases, development of which is an important goal of both marketer and user.

The rewards for this program are many: simplified manufacturing, packaging and marketing for the grease maker; simplified buying, storage and dispensing for the grease user. The results of such a program are a better grease and, although multi-purpose greases may be higher in initial cost, greater over-all economy.

It must be realized, however, that there will always be certain specialized applications where peculiar conditions require a tailor-made product. The quality characteristics built into lubricating greases are the responsibility solely of the grease manufacturers.

LUBRICATING GREASE PACKAGING

Uniformity of grease packages as to size, form and style of opening is a forward-looking step which would certainly serve to improve service to lubricating grease users. Grease packages are designed with several objectives in mind: ease in filling and dispensing, protection of contents, convenience in handling and economy. Harmony in design would well promote these objectives.

LUBRICATING GREASE DISPENSING

Coordination of grease dispensing equipment may be a little more difficult to achieve but would, perhaps, be just as noteworthy. Manufacturers of grease guns, grease pumps, grease cups and fittings and centralized grease systems have done an excellent job of providing suitable dispensing devices. Conformity of grease fittings and pressure guns has, of necessity, already been achieved. Further progress might be achieved in making both containers and dispensers more uniform to improve the ease with which the dispenser is attached to or filled from the container.

Another important factor in connection with the design of grease pumps and central grease systems is that property of greases known as pumpability. Our NLGI Panel on Delivery Characteristics of Dispensing Equipment for Lubricating Greases is working on the problem of correlating equipment performance with properties of lubricating greases. One result of this work, for example, could be a system for rating grease guns as to which greases can be properly handled.

A program of coordination, with all its attendant benefits, would lead to better harmony and better lubricating service through improved products, containers and dispensing equipment.

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SPOKESMAN TAKES NEW NAME AND COVER

In March, 1937, a four-page publication made its appearance in the lubricating grease industry. It was called "THE INSTITUTE SPOKESMAN" and has been known by that name to this issue. Believing a title more descriptive of both contents and sponsoring organization more appropriate, a new name is being voted by Active Members. Our new name is "NLGI SPOKESMAN." A change has also been made in our cover design to permit more space for illustrations.

ABOUT THE COVER

The building pictured houses Emery's revolutionary ozone-oxidation process for the manufacture of azelaic and pelargonic acids. This first large-scale use of ozone by the chemical process industry will increase substantially the availability of these unique acids.

Because of this favorable supply situation and the higher purity of products now attainable, Emery esters of azelaic and pelargonic acids have commanded considerable attention as mono- and diester components of synthetic lubricants and bases for synthetic greases.

One important characteristic of synthetic lubricants, their resistance to oxidation and corrosion, is measured by the testing equipment also pictured on the cover. This is only one of the many tests involved in meeting such Military Specifications as MIL-L-6387 (Synthetic Base, Lubricating Oil) and MIL-L-7808-A (Lubricating Oil, Gas Turbine, Aircraft).

While Emery has always been most closely identified with the manufacture of fatty acids, these unique diesters further broaden the scope of products that Emery supplies to producers of lubricants and lubricating greases.

HIGH TEMPERATURE LUBRICATION OF ELECTRIC MOTOR BALL BEARINGS

by J. E. Brophy, J. Larson, C. R. Singleterry and W. A. Zisman

Lubrication Branch, Chemistry Division

Naval Research Laboratory, Washington, D. C.

(This article is composed of excerpts from NRL Report 3971)

ABSTRACT

The 5-year program just completed was aimed at the development of greases and ball bearings suitable for lubricating electric motors at bearing temperatures from −40° to 150° C. Research activities of this Laboratory were coupled with those of a number of leading industrial manufacturers of electric motors, ball bearings, and lubricants by means of an industrial cooperative committee of the Bureau of Ships. As a result of this development program, recommendations were made to the Bureau of Ships upon which was based the recent Specification MIL-G-15719 (Ships).

New or improved methods for laboratory testing of greases and for bench testing of motor ball bearings were evolved for use at 150° C. Nine newly developed greases (all of which are now commercially available) were investigated and tested jointly. These included a mineral oil gelled with a strontium soap, two mineral oils gelled with sodium soaps, a mineral oil-diester blend gelled with lithium soap, a polyalkylene glycol derivative gelled with lithium soap, and four silicone greases one of which was gelled with carbon black and the others with lithium soaps. Only the silicone-lithium soap greases were useful at 150° C. for over 1000 hours of operation without regreasing. Lowering the temperature to 125° C. resulted in a large increase in the life of all greases tested; the silicone-soap grease having a clear advantage over all the others. However, several nonsilicone greases gave dependable operation at 125° C. for 1000 to 2000 hours without regreasing. For operation at 100° C. the three soap-gelled silicone greases and three of the nonsilicone greases gave 10,000 to 15,000 hours of satisfactory operation without relubrication.

For maximum utilization of the class H insulation in motors, the lubrication system should be so designed that the grease reservoir will tend to inject fluid into the bearing or that the fluid bled from the greases will migrate into the bearing. Rotating shields on the bearing, a larger reservoir of grease within the bearing, sealed bearings, use of nonferrous materials for separators, and use of bearings stabilized at higher temperatures should all be considered in future designs. Until such design changes in bearings and end bells have been effected to make the best use of greases at high temperatures, the relubrication interval should be between 500 and 1000 hours for continuous operation at 150° C., or much less frequent if operation is below that temperature for over 50 per cent of the time.

History of Problem

During recent years one of the significant electrical developments has been the application of silicone-glass insulation to the windings of rotating electrical equipment. The high-temperature properties of this material offer distinct advantages over conventional insulating materials and permit greatly increasing the power output of electrical units without increasing the physical dimensions. However, in totally enclosed units this increase in output causes a corresponding increase in the amount of heat produced, which often results in bearings and lubricants being subjected to temperatures higher than the previous specification limit of 80° C.

A conference was called to initiate a coordinated program for developing and testing electric motor ball bearings and lubricants for operation in the upper range of

temperatures generated in the silicone-insulated motors and to explore the possibility of immediately increasing the upper temperature limit to 90° C. in silicone-insulated motors already in operation. In view of the increased importance of operations in the arctic regions, attention was called to the need for a low-temperature limit of −40° C. The ideal condition sought was that each prelubricated bearing should operate over the range from −40° C. to 150° C. without relubrication for a period of five years.

In another meeting in July 1945, (6) the newly formed committee for "Electric Motor Ball Bearings and Lubricants for High-Temperature Operation" established tentative standard conditions and a test procedure. Prior to the establishment of the cooperative committee, the Bureau of Ships had been interested in silicone motor performance at temperatures approaching 200° C. However, the advice of the committee was accepted that 200° C. was impractical for the bearings and lubricants available. It was tentatively agreed that the test temperature of the bearings would be 125° C. since this temperature was already being encountered in some silicone-insulated motors. Ball bearings and lubricants were to be considered satisfactory if they operated 4000 hours without relubrication. The factors which were to determine premature or final test failure were as follows:

1. Increase in noise level
2. Increase in vibration over initial vibration
3. Rapid increase in the bearing temperature
4. Sudden decrease in coasting time
5. Leakage or hardening of the lubricant
6. Broken or inoperable conditions—stalling

It was also decided to use standard ball bearings as provided in Navy Department Specification 42N5. Each bearing was to be marked with a serial number by the manufacturer and measurement was to be made by him of the various component bearing parts before and after the tests had been conducted. In order to facilitate the procurement and distribution of the test greases, the Naval Research Laboratory was asked to procure or make sufficient quantities of the greases selected for testing from one production batch, to obtain the necessary analytical and physical data on each grease for use by the committee and to distribute the greases in 10-pound lots to the participating members operating the test equipment. In conjunction with the testing at higher temperatures, it was agreed to "cycle" or shut down the motors over the week end to study the thixotropic and regenerative properties of the greases and their possible effects on the life of the test runs.

Electric Motor Bearing Equipment and Test Procedure

The motor generator sets utilized by the committee for the cooperative tests were procured from the Westinghouse Electric Corp. by the Bureau of Ships and were distributed to the members in the latter part of 1945.

Each test unit consisted of two identical 440-volt, 4.5 h.p., Type CS, 3 phase, 60 cycle, totally enclosed, standard naval shipboard motor frames (No. 324) which housed windings with Class H (AIEE Standard) insulation. The units, shown in Fig. 1, were mounted on a bedplate and coupled by a multiple (4) V-belt drive.

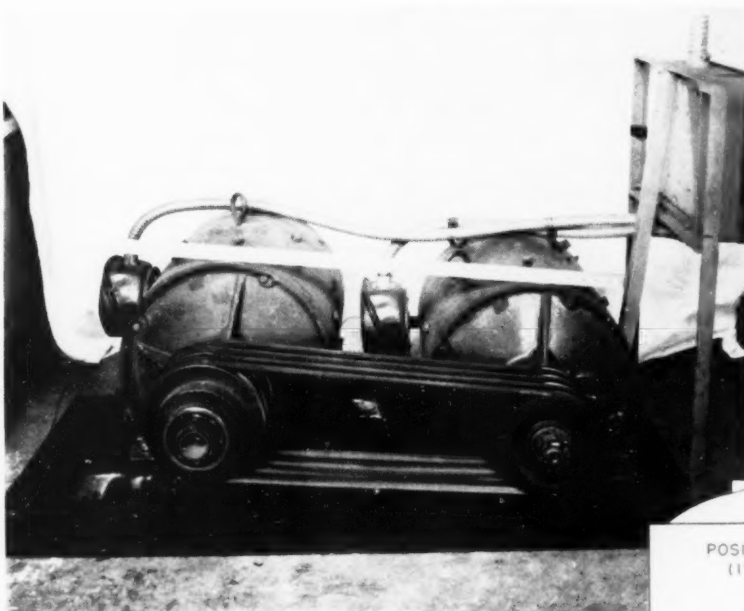

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FIGURE 1—Motor generator test set

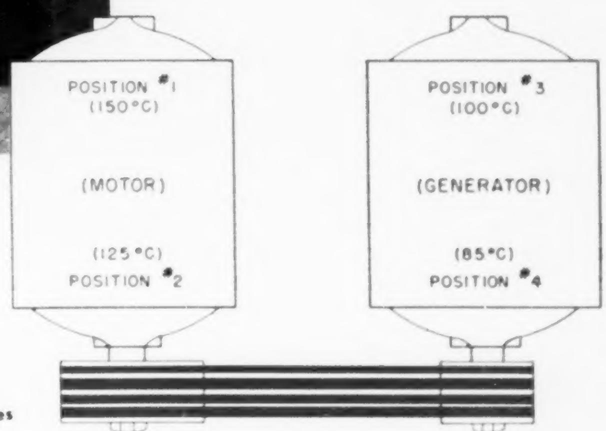

FIGURE 2—Bearing positions and temperatures

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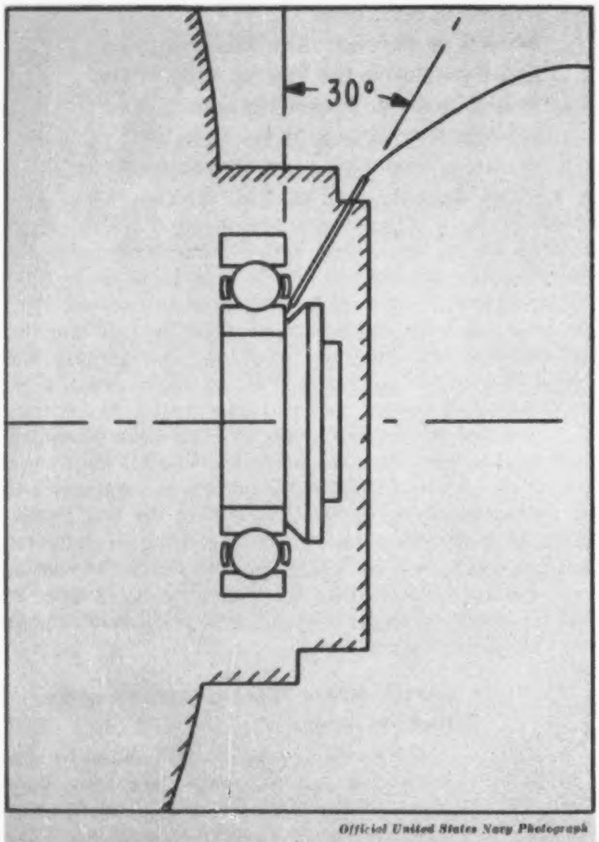

FIGURE 3—Effect of bearing stabilization temperature

The sheave arrangement included a 7½-inch pitch diameter adjustable sheave on the driving unit (motor) and a smaller 6½-inch pitch diameter nonadjustable sheave on the driven unit (generator). The rated speed of both motors was 1725 rpm, and under test conditions the speeds were approximately 1640 and 1845 rpm on the motor and generator respectively, with slight deviations dependent upon the power requirements of the individual units to maintain the required temperatures.

Since the primary objectives of the program were principally concerned with the effects of elevated temperatures on the greases and bearings, provisions for the application of additional radial loads were omitted and operation was essentially under no load conditions since the weight of the rotor, sheaves and belt tension were a negligible part of the rated load carrying capacity of the bearings.

At the next meeting in December 1946 (7), an alternate test method was proposed and accepted by the committee. The sheave ratio was increased by readjustment of the adjustable sheave to increase the temperature of the hottest bearing from 125° C. to 150° C. All artificial methods of increasing or adding heat to the remaining three bearings were eliminated. The other three bearings were allowed to operate at their equilibrium temperatures as follows: the pinion-end bearing of the motor (driver) was approximately 125° C., the temperature of the bearing opposite the pinion end on the generator was approximately 115° C., and the temperature at the pinion end of the generator was approximately 90° C. The bearing positions were numbered in the order shown in Figure 2 with the "controlled" or test bearing designated as No. 1. This revised procedure proved satisfactory for the balance of the program.

At the beginning of the program the initial grease charge in the bearing and the amount of grease loaded into the end-bell grease reservoirs were as follows: The two No. 310 bearings, which were mounted on the end opposite the pinion end on both the motor and the generator, were charged with 10 grams of lubricant; the end-bell grease reservoirs opposing each of these bearings were filled with 20 grams of the same lubricant; the other two bearings (No. 311) located on the pinion end of the units were charged with 15 grams of the desired lubricant; and the end bells opposing these bearings were loaded with 30 grams of the same lubricant. These quantities were recommended by the manufacturer of the test sets and were based on the amounts usually adequate for operation at conventional bearing temperatures. However, during the course of the test program, the committee agreed that exposing the greases and bearing to the elevated temperatures promoted accelerated rates of bleeding and oxidation and therefore the quantities of lubricants initially charged into the bearings should be increased in an effort to compensate for the effect of the temperature. Half the volume of the available space in the bearings was accepted as the new amount of lubricant with which to charge each bearing and end bell at the beginning of each new test. Therefore, the two No. 310 bearings were charged with 25 grams of lubricant, the end-bell reservoirs opposing these bearings were to contain 20 grams, the No. 311 bearings were charged with 25 grams, and their opposing end-bell reservoirs with 30 grams of the lubricant. The bearings were to be hand-packed, and care was to be taken to fill the cavities in the bearing with as much of the initial charge of grease as possible.

It was agreed that each grease be tested at least twice in the "controlled" or 150° C. bearing. The type of grease in the other bearings was to be changed with each failure of the particular position. Prior to setting up each new test run, the area surrounding the bearing was to be thoroughly cleaned of all grease or residues from the previous test.

The bearings in No. 1 and No. 3 positions were No. 310, single-row, single-shield ball bearings, and in positions No. 2 and No. 4 were No. 311, single-row, single-shield ball bearings. The bearings were to conform to the Specification 42N5. Prior to the installation of the bearings into the units for testing, the following preliminary procedure for the removal of the slushing compound on the bearings was to be adhered to:

The test ball bearing shall be washed by spinning it slowly partly submerged in a bowl of Stoddard Solvent (ASTM-484-40). The bearing shall be washed in bowls of clean Stoddard Solvent until it is clean and free from all lubricant or slushing compound. The ball bearing shall then be rinsed in a bowl of clean petroleum ether (ASTM-D-128-40 reagent) and flash dried in an oven at 160° F. just prior to lubrication for test.

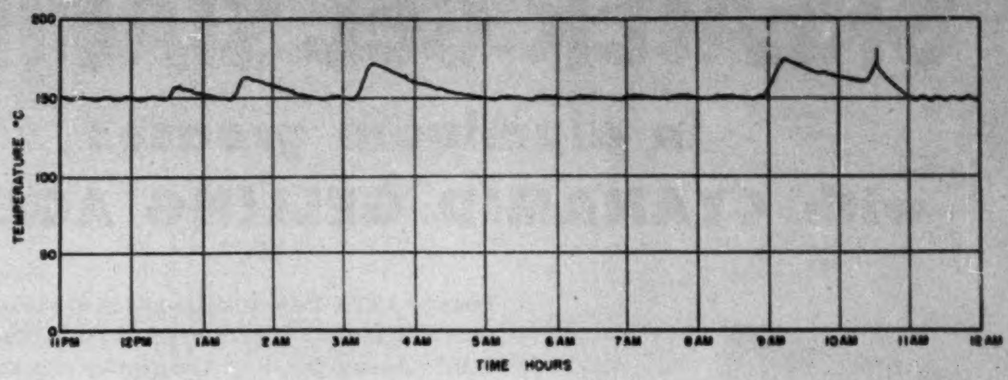

FIGURE 4—Typical temperature flashes with a silicone grease

After a trial period, the committee agreed that the coasting time had proven to be merely an indicator of deterioration rather than of bearing failure. Therefore, the time consuming measurement of the coasting time was eliminated. The termination of tests by means of the other criteria listed, with the exception of item 6, was based solely on the judgment of the individual operator. When combined with the individual peculiarities of each grease this caused an undesirable scatter in the test results. For example, during each test run with each grease, the noise and vibration level would increase; yet after continued operation the noise would cease and the test continue normally for an extended time. Under these circumstances the use of the first and second criteria might lead an operator to terminate the test prematurely during the noisy period. The same difficulty arose in applying the third criterion, since it had been noticed (particularly during the silicone, grease runs) that transient temperature rises or "temperature flashes" occurred during the test. More normal temperatures would return and continue for long intervals thereafter. It was apparent that the criteria determining failure of bearings and lubricants at conventional temperatures could not always be applied to tests at the more elevated temperatures.

For better service simulation of motors which do not operate continuously, the test procedure was modified so that the test sets were periodically "cycled" or shut down long enough to permit the grease to cool down to room temperature. The purpose of the change was to evaluate the regenerative and thixotropic properties of the greases. If the grease was not capable of providing adequate lubrication to the bearing when cooled, it could not pass the requirements of noise level, hardening of the lubricant, or stalling. The inclusion of the "cycling" period in the program was an important factor since many of the tests failed as a direct result.

During the exploratory work early in the program, NRL reported the existence of a temperature difference as high as 30° C. between the inner and outer races of the bearings (8). This differential is due to heat generated by the electrical load in the rotor windings and in the shaft. Since the rotor shaft provides a path for the dissipation of the heat to the motor frame, the intimate contact of the inner race to the shaft usually results in higher inner race temperatures. At test positions No. 1 and No. 3, where the bearings are mounted on the stub end of the shafts, the temperature differentials between the races were reported to be the greatest. At positions No. 2 and No. 4, the larger bearings and shaft extension which supported the sheaves offered more surface for heat dissipation, and consequently the temperature difference was reduced nearly to zero. Since a temperature difference between the races could alter the initial clearances in the bearings while a rise of temperature would deteriorate the grease, it was evident that information on both inner and outer race temperatures would be important in the final evaluation of the test results. This proved to be correct and is discussed more fully later. As machine designers and manufacturers customarily use the outer race temperature, it was agreed to use the outer race temperature as the reference temperature and to include the inner race temperature on the data sheets.

The original test units were provided with holes in the bearing housing to measure only the outer race temperature of the enclosed bearings. Provisions were made at NRL for measuring the inner race temperature by the method illustrated in Figure 3. To reach the edge of the inner race it was necessary to drill a hole from a location and at an angle (approximately 30°) which would clear any obstructions in the path of the thermocouple. The angle of the bearing lock nut was altered by machining to provide more clearance for the thermocouple. The drilled hole was large enough (0.187 inch) to accommodate a steel tube in which the thermocouple wire had been silver-soldered. This type of thermocouple arrangement assured positive contact on the inner race edge. It was necessary to stop the rotation of the units at the time the inner race temperatures were to be measured, but careful determinations showed that the inner race temperature remained essentially the same for a period of three minutes. This was adequate time to make the temperature measurement. It was found that inserting the thermocouple into the hole (but not deep enough to touch the rotating bearing) was sufficient to bring the thermocouple temperature near that of the bearing; thus a shorter time was necessary for measuring the temperature of the race when the units were stopped. Although the inner race temperature was measured only periodically, the outer race temperature was recorded continuously.

Continuously recording the temperature of the outer races demonstrated that the type of failure occurring

Table I

COMPOSITION AND PHYSICAL PROPERTIES OF GREASES

Grease	Gelling Agent: Type	Gelling Agent: Amount (%)	Fluid: Type	Viscosity (centistokes) 100° F.	Viscosity (centistokes) 210° F.	Viscosity (centistokes) 300° F.*	V. I.	Dropping Point (° F.)	ASTM Penetration W60 at 77° F.
A	Strontium Soap	20	Mineral Oil	461	32	9.8	106	400	300
B	Sodium Soap	..	Mineral Oil	90.9	9.88	3.8	91	...	297
C	Sodium Soap	24	Mineral Oil	277	20.1	6.3	92	452	289
D	Lithium Soap	20.6	Mineral Oil Diester Blend	13.5	3.4	1.8	145	368	286
E	Lithium Soap	..	Polyalkylene glycol Derivative	268	38.6	14.5	142	404	229
F	Carbon Black	9	Methyl Phenyl Silicone	56	15.5	8.0	163	400	304
G	Lithium Soap	20.4	Methyl Phenyl Silicone	53.2	14.8	7.6	165	411	290
H	Lithium Soap	24.6	Methyl Phenyl Silicone	101	29.5	15.0	152	416	311
I	Lithium Soap	22	Methyl Phenyl Silicone	82.8	18.3	8.5	154	414	263

*Estimated from the measured viscosities at 100° and 210° F. by a linear extrapolation on the modified ASTM chart

with greases essentially organic in nature was different from that with silicone greases. The temperature records showed that regardless of the gelling agent used, all silicone greases exhibited the same characteristic types of failures and temperature flashes. These temperature flashes, of which Figure 4 is an example, occurred during a large number of the silicone grease runs at NRL. The temperature flashes varied in frequency and, although they were occasionally accompanied by noisy operation, they sometimes occurred without noise. All tests with nonsilicone type greases were free of evidence of temperature flashes until just prior to final and decisive failures. In contrast, the temperature flashes which occurred during the silicone runs were not always an indication of imminent failure; often after the temperature flash the temperature became normal and operation was satisfactory for several hundred hours before final failure. Later reports of participating laboratories indicated these temperature flashes also occurred during their test runs.

During the last several years of the committee program, the test sets at NRL were modified as shown in Figure 5 to include a removable inspection plate in place of the boss normally located directly in front of the controlled test bearing. Although the view of the entire bearing remained somewhat limited, the modification provided a means for observing the effect of oxidation on the greases as the test progressed. One of its most important contributions was the observation of the bearings during the temperature flashes and at failure. Visual inspection of the silicone grease test runs when failure was imminent showed that the residues remaining on the ball separator were completely dry and the races were devoid of fluid. However, during the short period prior to disassembly of the unit, the bearing and the grease residue on the ball separator were found to have been well saturated with fluid released during the temperature flash from the unexhausted portion of the grease that had remained in the system. Prior to the installation of this inspection plate it would have been virtually impossible to determine the reason why the same apparently well-lubricated bearing should have failed.

Materials Tested and Physical Constants

The greases finally subjected to cooperative testing are listed in Table I together with some information on composition and pertinent physical properties. In addition to the main components given, most of the greases contained oxidation inhibitors; some were also stated to contain a rust inhibitor.

As indicated by the distribution curve in Figure 6, the peak of distribution of grease A, a mineral oil and strontium soap grease, is in the region from 200 to 400 hours. Although a small concentration existed at 400 to 600 hours for grease B, which was prepared from mineral oil and a sodium soap, there still remains a spread in the results. The third grease C, which was also prepared from a petroleum oil and sodium soap, was included rather late in the program. Consequently, a more limited amount of data was available than for the other greases. However, the data obtained and the post-test examinations of the bearings suggest the peak of the distribution curve is probably in the vicinity of 400 to 600 hours.

Synthetic fluids other than silicones were used as the base fluids in two of the program greases. The first of these is grease D, which is a mixture of petroleum and diester fluids gelled with lithium soap. This grease was manufactured for specification Mil-G-3278 and not specifically for high-temperature operation, but it was included in the program for comparative purposes. The distribution curve shows a well defined peak in the vi-

Official United States Navy Photograph

FIGURE 5—Inspection plate and inner race thermocouple

cinity of 200 to 400 hours with no spread beyond 800 hours. The second of these, grease F, which was prepared from a liquid polyalkylene glycol derivative gelled with lithium soap, gave a distribution peak in the vicinity of 400 to 600 hours and no runs lasted over 1200 hours.

Four greases compounded by gelling silicone fluids formed the final group of the series. Data for grease F, which was gelled with carbon black, showed that although a small group of runs lasted between 1200 and 1400 hours, the wide spread of the remaining runs made the average of the distribution curve of questionable significance. Similarly, the information on greases G, H, and I, which were all compounded with silicone fluid and lithium soap, showed a wide spread in the bearing lives.

Several uncontrollable variables operated to produce spread of the test results:

1. Post-test examinations disclosed that the bearings which ran longest occasionally suffered a greater degree of damage because they had been run beyond the effective lubricating life of the grease. These bearings usually had broken separators and or races which were in an advanced stage of fatigue and there were relatively large amounts of iron particles.

2. Some operators terminated runs due to a noisy condition at the beginning of a cycle in bearings which still contained grease able to continue lubrication. This noise was found to be the result of hard deposits which formed on the races during the cool period of the cycle. Other operators in the same circumstances permitted the machine to operate under these noisy conditions until the unit warmed up and the deposits either softened with the heat or were thrown from the bearings.

3. The methods used to pack the bearings with the initial charge of grease affected the life of the runs. Examinations generally showed that those bearings which contained the greatest amounts of residue in the bearing itself at the end of the run usually ran the longest.

4. The difference in temperature between the inner and outer races affected the length of the test runs. The effect was most marked with silicone greases.

5. Silicone-lubricated bearings which lasted 4000 hours or more generally revealed little wear on the separator. A few bearings which ran 4000 hours experienced heavy wear which occurred late in the run. All the bearings which failed prior to 4000 hours revealed excessive amounts of wear on the separators.

The excessive amounts of wear in the bearings which failed prematurely (as judged from the condition of the grease remaining in the bearings), was one of the factors responsible for the noisy operation reported as the criterion on which some of the runs were terminated. This was particularly true in the tests where the bearing was noisy on restarting after a cycling period. Observations through the inspection plate at NRL at the beginning of cycling period showed the loose separator vibrating on the balls due to stiffness of the grease in the bearing. On heating (which softens the grease) this noisy condition would cease and normal operation continue until the next period was encountered or until the separator had worn enough to contact the inner race rim.

Another reason for noisy operation (and therefore a reason for terminating the run) was the occurrence of deposits which were dry and hard enough to cause roughness and therefore noise in the bearing. Observation in the Visual Tester discussed later revealed that these deposits were formed slowly in the absence of a temperature flash and more quickly with one. These deposits occurred both early in the run and late in the run. They were not of a permanent nature since they were removed by either a discharge of fluid to the races from the grease mass on the race rims or by the rotation of the balls. The end-bell grease samples of many of the runs were found covered with small black, hard, rubbery particles which were the deposits thrown from the races.

Location of Grease with Respect to End-Bells

Examination of the end-bell samples of grease submitted with the failed bearings indicated that the grease in the end-bell cavities was contributing very little toward the lubrication of the bearing. This was evident from the amount of unexhausted grease found in the sample even after the bearing had failed due to insufficient fluid to lubricate the races. There were two primary reasons why the end-bell reservoir proved to be ineffective: (a) the location of the cavity in respect to the bearing which did not permit effective bleeding to the races, and (b) the oxidized surface of the end-bell grease which prevented bleeding of fluid to the bearing.

Inspections disclosed where excessive bleeding was reported that the fluid bled had drained down the surface of the end-bell to space at the bottom of the end-bell rather than to the bearing. This indicated that the fluid from the

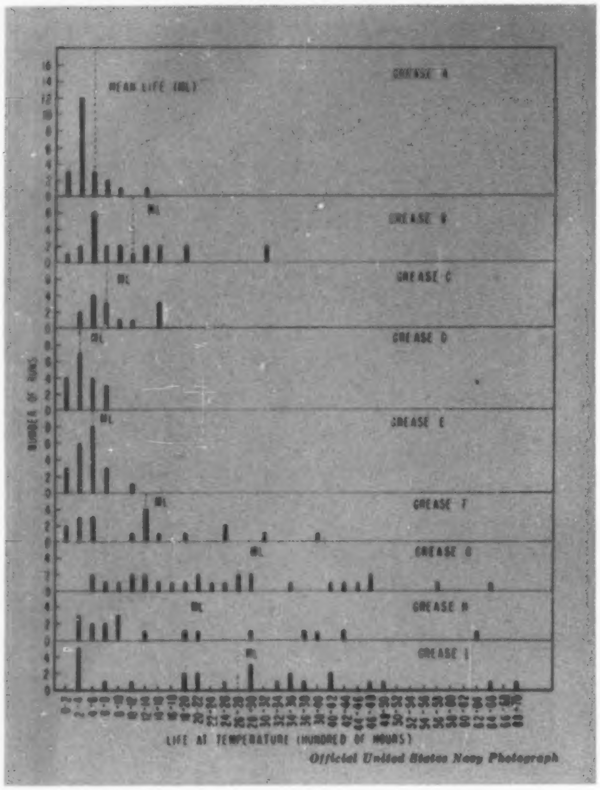

FIGURE 6—Operational life with different greases at 150°C

grease reservoir in the end-bell would not be distributed to the races even in normal bleeding procedure. With all greases the surface of the grease in the end-bell oxidized to form a hard surface. This surface restricted the passage of the fluid from the underlying grease to the races. Therefore, there remained relatively large amounts of grease which could not be utilized for its intended purpose.

In view of the above points, redesign of the grease reservoir would be desirable to insure the transfer of fluid directly to the races from the grease in the reservoir (end bell), to prevent the products of oxidation from forming a barrier to the fluid bled from the underlying grease, and to utilize fully the initial grease charge.

Discussion of Results

There are at least three numerical performance ratings possible for each grease. They are useful for determining immediate operating procedures with motors, and for extrapolating possible long range improvements in performance of grease lubricated equipment. The numerical ratings characterize:

1. The minimum life (reached by 90 per cent of the bearings tested)

2. The mean life (of all bearings lubricated with a given grease), and

3. The maximum life (as attained by the best 10 per cent of the bearings lubricated with a given grease).

Item 1 bears directly on the preliminary establishment of lubrication schedules for motors operating with maximum outer race temperatures of 150° C. An examination of the average of the 20 per cent of shortest runs (Table II) suggests that there is little difference between the soap-silicone greases and the petroleum greases. However, the average of the 20 per cent of longest runs shows that a substantial number of bearings lubricated with any one of the soap-silicone greases operated for six months or longer. If a silicone grease did not fail at an early period it could be expected to have a long life. The failure of the remaining tests to run so long must be attributed chiefly to uncontrollable variations in the test procedure, including misalignment, temperature differences between inner and outer races and other variations in the test bearings. If these uncontrolled variables could be identified and controlled, the silicone greases now available would permit the routine operation of motors at 150° C. with relubrication at intervals of four or six months. Conventional high-temperature petroleum greases now available could similarly be used on a two-month relubrication schedule.

The petroleum greases show a concentration of test results in some specific 200-hour period, but are almost uniformly scattered through the rest of their characteristic range. The lives obtained at 150° C. with soap-silicone greases, however, show no tendency to cluster at any characteristic point within the range of 400 to 6000 hours. This absence of a characteristic life expectancy about which the test results are normally scattered may indicate that the condition of the grease present was not the controlling factor that determined the lives obtained. This conclusion is supported by the observation that soap-silicone residues in bearings which operated less than 4000 hours did not appear (apart from contamination with magnetic wear products, to have deteriorated beyond the point where they could serve as lubricants. The need for a vigorous research attack on the control of the variables in bearing operation that are responsible for the large spread in test results at 150° C. is indicated.

Table II

LIFE OF BEARINGS AND GREASES AT 150° C. (SUMMARY)

	Life (hours of operation)			*Number of*
Grease	*Minimum**	*Mean*	*Maximum†*	*Runs§*
A	202	413	850	22
B	320	1094	2487	22
C	363	798	1545	14
D	189	383	680	18
E	196	463	843	21
F	213	1328	3089	19
G	812	2710	5252	27
H	373	1850	4683	18
I	341	2799	5604	25

*Reached by 90% of greases (average of lowest 20%)
†Reached by highest 10% of greases (average of highest 20%)
§Made with bearings stablized for operation of 170° C.

The soap-silicone greases indicate a longer service life in the 125° C. range than do the petroleum greases. However, if the improvements in the formulation of nonsilicone greases pointed out in a later section are realized, and if the modifications in bearing and housing discussed below can be effected, motors lubricated with suitable petroleum or ester-type greases can be operated routinely for 4000 hours with maximum outer race temperatures of 125° C. Greases for such service, however, must be given adequate functional testing before acceptance. Very wide differences in life at 125° C. may be expected from the various greases now qualified under specification AN-G-5a.

Not enough data were reported on the performance of the program greases at 100° and 80° C. to permit significant estimates of the life that may be expected with each lubricant at these lower temperatures. The preliminary data reported by the Engineering Experiment Station in October 1949 indicate clearly that at 90° C. to 100° C. a life of 15,000 hours without relubrication may be obtained with several soap-petroleum high-temperature greases, as well as with all three of the silicone greases studied. (This work will be reported separately by EES when it has been completed.)

Examinations of Bearings and Grease Residues

Examination of the post-test grease residues at NRL included microscopic inspection of the residues to determine the cause and extent of grease deterioration and a test to determine the amount of iron or magnetic iron oxide present. The "magnetic particle test was made after dispersing about 10 milligrams of the residue in a suitable solvent in a Petri dish. A magnet was then moved under the dish to attract and permit removing and weighing the magnetic particles. The presence of such particles indicated that wear, scoring, or both had occurred during the motor test.

These simple tests led to a number of useful conclusions. The surfaces of the ball separator and race rims of the bearings with grease A were generally found covered with badly discolored (dark-reddish-brown), stiff, tacky or dry residues. Although a few bearings showed traces of residual oil on the outer surfaces of the race rim, the ball races and tracks were usually dry and caked with hard black deposits. The grease residues were found free of magnetic particles, except in tests where the bearings had obviously been run beyond the useful lubrication life of the grease and consequently suffered severe damage.

Residues in bearings run with grease B had usually deteriorated into dark brown granular structures which ranged from tacky to dry. When bearing operation had not been extended beyond the useful lubrication life of the grease, magnetic particles were absent. However, several bearings were coated with a fine magnetic powder indicating that wear or scoring had occurred after the bearing had become exhausted of lubricant.

Although the above descriptions of the residual products applied to most of the bearings examined, a number of the bearings that failed still retained a relatively large amount of unexhausted grease on their outer surfaces. These particular bearing tests had been terminated because of excessive noise on restarting after a cycling period. Examination disclosed that resinous deposits, which had cooled and stiffened on the races during the cycling period, were responsible for the noisy operation in such cases.

Samples of greases from the end-bells all appeared quite similar. Generally, the outer surfaces of these greases (the surface exposed to the bearing) had deteriorated into a hard or plastic discolored structure. Since the bottom of the end-bell groove remained at a relatively low temperature, a cross section of the end-bell grease sample frequently showed that under the outer oxidized layer there remained grease which although discolored retained some of its original characteristics.

Examination of the bearings run with any of the silicone greases gelled by soaps disclosed post-test residues considerably different than those found with the nonsilicone greases. Greases G, H, and I, which were essentially of the same composition, left similar residues. In bearings which had failed in less than 2500 hours of operation, the ball separator was generally thinly covered with a discolored, stiff, polymerized structure. However, on the race rims there usually remained a considerable fraction of discolored but unexhausted grease. Bearing races were generally covered with soft, gritty, black deposits which were still saturated wtih silicone fluid. In bearings which had operated over 2500 hours, the grease residues were generally in various states of polymerization and exhaustion which were more pronounced the longer the test period. In bearings operated over 4000 hours residues were found exhibiting the most advanced stages of polymerization, the residues being black, rubbery, and exhausted of fluid. The races of these bearings were usually covered with tacky, black residues incapable of lubricating the surfaces for much longer.

As for grease F, the only silicone grease of the nonsoap type in the program, when the duration of the test exceeded 3000 hours, the grease residues found in bearings were usually a mixture of soft grease and harder, rubbery particles. The rubbery particles were not necessarily a product of long operation at high temperature since several bearings which had failed after only 200 hours of operation contained greater amounts of the rubbery residue than bearings which had failed in approximately 3000 hours. Grease F generally showed a greater tendency to collect in the recesses of the bearing than the soap-silicone greases; consequently, the recesses and races of bearings which ran about 3000 hours bcame so clogged with the heavy rubbery residue as to retard the rolling action of the balls.

End-bell samples of both types of silicone greases usually remained relatively unaffected in tests lasting less than 3000 hours. However, the region of the grease nearest to the bearing developed a slightly lower penetration, and often contained numerous particles of polymerized oil ejected from the races during the test.

The condition of the separate parts of the bearings at the end of the tests was found to be dependent upon the condition of the grease that remained in the bearing at the time of failure, the time of operation beyond the point of

exhaustion of the grease, and the temperature of the inner race. Residues and surfaces of bearings lubricated with nonsilicone greases appeared similar. Runs continued beyond the point of exhaustion of the grease caused surface damage varying from severe subcutaneous damage and wear to the tearing of a few particles from the separator and races. When the inner race was hotter than the outer race, more damage occurred on it than on the outer race. The amount of wear of the separator was very small, and occurred after the grease was devoid of fluid and just prior to failure. It was probably an insignificant factor in determining the failure of tests on such nonsilicone greases.

The ball tracks of both silicone and nonsilicone lubricated bearings which had not been run to destruction often exhibited a characteristic appearance uncommon in bearings which have been operated only below 100° C. The track was covered with a glass-smooth amber glaze through which the underlying crystal pattern of the metal showed as if it had been chemically etched. In one run with a silicone grease a large amount of airborne debris was found on the inner surface of the end bell and on the other parts of the housing. This material appeared black en masse. It was magnetic, and microscopic examination showed it to consist of fragments of yellow or brown transparent film so thin that the thickness could not be resolved in an edge view at 400X magnification. The fragments were strongly birefringent and magnetic. They were identified by chemical test as an iron compound. The properties correspond very closely to those of the thin oxide films formed during the first stage in the oxidation of iron surfaces at annealing temperatures. A few fragments of a similar nature were found in the grease residues from runs with greases D and E. If such films were torn from the races during temperature flashes, very rapid wear would result. At the same time the lubricating oil film would be stripped from the ball track leaving it temporarily dry. Since instantaneous skin temperatures on the track as the ball passes may rise many degrees above the bulk temperature of the race, it is not difficult to understand the slow formation of such an oxide glaze.

SUMMARY

Uncontrolled Variables

It is unsatisfactory for research and development purposes to run motor bearings to destructive failure since post-test examinations are rendered difficult and indicative data on the causes of failure often are lost. Several variables contribute to the scatter of the results; the more important variables are summarized below.

An increase in noise level of the bearings determined qualitatively by the operator was a widely varying method of determining the end of a run. A possible method of determining this end point more closely would involve the use of a sound level meter or noise analyzer while the bearing is operating at high temperatures. This method has been found valuable in recent gyroscope lubrication studies (11) of this Laboratory. Marked increase of input power or prolonged temperature increases may be used as indications of excessive torque requirements and hence of poor lubrication. The inability to start after the motor has cooled off also serves as a worthwhile indication of the degradation of the lubricant.

Large temperature differences between the inner race and the outer race decreased the test life of a given grease. For further development work on high-temperature greases and bearings, more satisfactory control is needed of both the inner and outer race temperatures. To do this may require special test equipment instead of standard motors.

Bearings used in this program were chosen with end play of 7 to 11 mils. This wide variation undoubtedly caused some of the scatter in the results. A closer selection of test bearings appears advisable.

The bearings containing the maximum amount of grease at the end of the run had the longest lives found for each type of grease. The location of grease in the bearing and end bell affected the life of the runs. Similarly, the cycle of heating the bearing can influence the life of the bearing (but probably had negligible effect in this program).

The extreme wear on separators lubricated with silicone greases caused widely varying lives. This variation may have been due to the presence or absence of silicone lacquers on the separators. As pointed out in the early meetings of this committee, the use of nonferrous metals for separators will aid in reducing the wear of the separators (1, 6). Among the most promising candidates are aluminum-bronze bearing alloys and plated separators (12, 13). The behavior of separators at high temperatures is unknown and should be examined to determine the appropriate operating clearances.

Correlation of Laboratory and Motor Tests

The results indicate that laboratory tests cannot be substituted for a performance test of 150°C. in specifying greases for the lubrication of motors to operate at this temperature. Such measurements, however, have been correlated sufficiently with performance data to permit the selection of greases for functional testing. Maximum limits for evaporation, bleeding and oxidation at 150°C. are suggested as follows:

Evaporation: Not more than 1.9 per cent weight loss after 50 hours at 300° F.

Bleeding: Not more than 12 per cent during 100 hours at 300° F.

Oxidation Stability: Not more than 5 psi drop from an initial oxygen pressure of 110 lbs. after 50 hours at 300° F.

Mechanisms of Grease Failure at High Temperatures

Nonsilicone greases cease to lubricate bearings adequately at 150° C. from a variety of causes. A volatile lubricating fluid evaporates rapidly from both races and bulk grease and the rate of loss from the race soon exceeds the rate at which oil is replaced by bleeding. In other cases oxidation forms volatile products that evaporate from the race. Petroleum oils oxidize and polymerize to give residues which lubricate at 150° C. but harden to resins upon cooling. A contributing factor to the short life

of the nonsilicone greases studied is their rapid bleeding at 150° C.

The deterioration of the silicone greases may result in part from excessive bleeding as a result of separation of the soap phase during a temperature flash, from contamination of the lubricant with the products of separator wear, and from the development of a rubbery oxidation product. The material formed shows long-range elasticity and is not to be confused with the slightly elastic horny or gummy residues observed with soap-type petroleum greases. This material resembles the gels formed by silicones when the latter are heated (14). None of the silicone greases of the program gave such rubbery products on prolonged heating at 150° C., either alone or mixed with iron powder or iron oxides. It must be concluded either that there are localities in the operating bearing that exceed 150° C. or that iron surfaces freshly exposed by the wear process are catalysts for the oxidation and/or polymerization of methylphenyl silicones.

It is probable that at elevated temperatures a new process of bearing wear becomes operative; this is the progressive oxidation of the bearing races. Such a mechanism will become critically important if operating temperatures are pushed to still higher levels and will require that attention be given to alloys with greater chemical as well as physical stability at the peak temperatures occurring in the bearings.

CONCLUSIONS

Most Satisfactory Greases

It is apparent that for operation at 150° C. greases must have lower susceptibility to bleeding, evaporation, and oxidation than has previously been required for high-temperature greases. The soap-silicone greases, G, H, and I are the only commercially available lubricants tested which hold promise for the operation of electric motors with bearing temperatures at 150° C. on a 4000 hour relubrication schedule. Until design changes to make the best use of grease at high temperatures have become effective, the relubrication interval should be between 500 and 1000 hours for continuous operation at 150° C. Experience may show that equipment which operates at 150° C. for less than 50 per cent of the time will require much less frequent lubrication even with present design.

Lowering the maximum operating temperature to 125° C. gives a large increase in life with all of the greases studied. The soap-silicone greases have a clear advantage over the nonsilicone types, but some available nonsilicone greases may already be depended upon for 1000 to 2000 hours of life. The improvements in motor design and grease formulation suggested here may reasonably be expected to provide reliable 4000-hour service with such lubricants.

At 100° C. all three soap-silicone greases will give 15,000 hours or more of satisfactory operation. In addition, there are several petroleum greases which will lubricate ball bearings for 10,000 to 15,000 hours at this temperature. It was found advantageous to use bearings which had been stabilized for operation at 150° C. to prevent loss of clearances due to growth. Bearings which meet the Navy Specification 42N5 were satisfactory for use at 125° C. and 100° C.

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Lisbon, Portugal
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Adoption of 120-Pound Full Open Head and Comments on Changes to Dispensi

This summary was prepared by F. W. Langner, chairman, Subcommittee on Metal Drums & Pails, Packaging Institute, Inc., for noncommittee members to give them an overall picture of the status of their work as reported at a meeting, June 8-9, in Kansas City, Missouri.

Work on standardization was started by the Petroleum Packaging Committee of the Packaging Institute in 1950. The proposed specifications for a 120-lb. Universal Grease Drum were sent to the API-NLGI Joint Container Committee in October, 1952. The proposed specifications were sent to the API-NLGI membership and when the writer last checked with R. C. Reed, Secretary of the API-NLGI Joint Container Committee, 29 of the 51 members had sent in a reply—16 for; 13 conditional and some against.

In view of the potential saving of 13% per drum, it is felt that the recommended drum has real advantages to the oil industry. At this time, the chairman of the Petroleum Packaging Committee, following instructions by the membership of the Committee as a whole, has advised the Steel Shipping Container Institute that its drawings for a 120-lb. Universal Grease Drum meet with the approval of our Committee. It follows that any drum manufacturer, who is making new dies, is now able to make them to the proposed standard dimensions. Any oil company that wishes to stay with the 100-lb. drum will be able to get it, but made to the standard diameter dimensions.

What is involved in the adoption of the 120-lb Universal Drum? The West Coast is to a great extent using a 120-lb. drum, but it is 4 inches taller than the present East Coast drum. However, by means of the use of either one of the three types of adapter pieces that are shown here, costing between 50-75c each, any piece of dispensing equipment can be used with the new 120-lb. Universal Drum. Incidentally, we have checked the cost, and have written quotations that the new 120-lb. Universal Drum made of 22 gauge metal for the West Coast will cost the same as the present drum.

Kindly note that when the adapter piece is fastened to existing West Coast dispensing equipment to adapt it for use on the 120-lb. Universal Grease Drum that the adapter piece does not spoil the appearance of the dispensing equipment and, in addition, it does *not* require additional work to change the equipment once the adapter piece is installed.

For the East Coast and Central States, where the present 100-lb. drum is used, if the new 120-lb. Universal Drum is adopted, the change could be made tomorrow, without changing one piece of equipment, or spending any money.

A short excerpt from a letter dated April 16, 1953, from a dispensing equipment manufacturer follows:

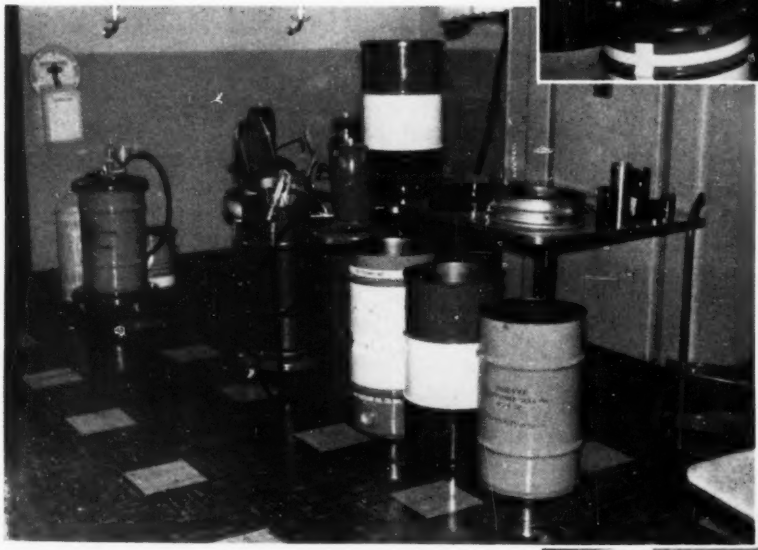
> "In fact, the present equipment can be used with the 120-lb. Universal Drum even without adapters, if the equipment owners desire. Of course, they might have to decant a little more product, but at least they could use the equipment. With the addition of minor adapters, their equipment can be adapted for use with the new style drum at relatively small cost."

At the time the proposed specifications were sent out to the API-NLGI membership, there were attached to the specification sheets comments and recommendations about changes to dispensing equipment. We have carried on developments with the (1) Lincoln Engineering Company, (2) Gray Company, (3) Aro Equipment Corp., (4) Balcrank, (5) Stewart-Warner, (6) Gilbert and Barker, and (7) John Wood. Each of these concerns has prepared a tabulation and data sheets showing how to change existing equipment or indicating equipment that does not require changes. Only Visi drum equipment needs to be changed if the user wishes to minimize decanting. We wish to emphasize that in each case, the changes made to any existing equipment is up to each organization to make its own decision. Some of the recommended changes will require a considerable expenditure of money.

The tests that were made on May 21st and are again being made here today show that the recommendations of the Metal Drum and Pail Committee were correct and that simple and inexpensive adapters are adequate. These recommendations were included with the specifications of the 120-lb. Universal Grease Drum that were sent out to the API-NLGI Joint Container Committee and the same data was attached to the Minutes of the October 20-21, 1952, Packaging Institute Meeting. We suggest that you refer to these Minutes and read them. As is apparent

Grease Drum
ng Equipment

F. W. Langner, chairman of the Metal Drum and Pail Subcommittee, discusses various types of adapters for existing grease dispensing equipment.



Existing 100-pound drums and the new 120-pound universal grease drums are exhibited. The two white banded drums and the two solid color drums, fourth and fifth from the right, are the 120-pound universal grease drums. Adapters are on the table.

A. D. Murphy, chairman of the Packaging Institute Petroleum Packaging Committee, shows the new 120-pound universal grease drum.

by the adapters that you see here today, there are no expensive changes or parts required, unless someone wishes to rebuild the existing equipment.

Some of the suggested methods of adapting existing equipment are being demonstrated here today. We are not going to make extensive tests, as this takes a lot of time. However, included with this summary are data of tests made with the same equipment and adapters. The products being handled here today are equally as difficult to handle as those used in our tests of May 21st.

Kindly read the conclusions reached from the tests that were made on May 21st, which appear on page 29, following the test data, as the results are very interesting and far-reaching.

In giving this demonstration, we hope that if you have any further selling to do within your own organization that you will make a similar demonstration for it is very apparent from the tests that have been made that there need not be any delay in adopting the 120-lb. Universal Grease Drum, and also that by the adoption of the standardized drum and by the use of the inexpensive adapters, where required, immediate economies in packaging can be made and improvements in the use of existing equipment can also be made because:

1. There is a direct reduction in cost of package of 13% and a reduction of 25% in packaging, handling, and paper work.
2. a. An adapter is not necessary on any so-called East Coast dispensing equipment to operate it on the 120-lb. Universal Drum.

   b. Actual checks with operators of grease guns have emphasized the fact that any smart operator changes to a new grease drum when the drum he is using is something less than ½ full. The former drum is put aside until space is available in the new drum. Operators have indicated that additional 2" of product are not objectionable in any manner or form.

   c. On Gear Oils where low pressure dispensing equipment with bottom suction is used, the same practice of decanting may be followed and in all probability in most instances would be followed by the operator if a 120-lb. drum is used, but by making available Neoprene hose and hose clamps through any TBA organization, each filling station operator is automatically equipped with a very cheap method of making an adapter, which in addition will in every instance improve the operation of his dispensing equipment.
3. In view of the points made in Item No. 2b above, we wish to make the important comment that by using a 120 lb. drum the filling station operator minimizes his change of grease drums by 1/5 and this is a very important improvement over the use of the present 100-lb. drum.
4. We wish to point out that from actual records kept by a major oil company when it changed from the 25-lb. lug cover pail to the 35-lb. lug cover pail that the following year it discovered that it had sold as many 35-lb. pails as it had sold of the 25-lb. units the previous year and consequently had increased its volume of business.
5. It is emphasized that starting immediately all dispensing equipment should be purchased complete with an adapter and by this means the necessity of West Coast special equipment can be eliminated and the dispensing equipment will then fit the 100-lb. drum, the new 120-lb. drum, and would even fit the present 120-lb. West Coast drum. With this simple and inexpensive adapter added to new equipment it follows that there would be no problem during the transition period from the present drums to the Universal drums.
6. After the 120-lb. Universal Grease Drum is in general use, another improvement of operation of heavy grease dispensing equipment would be to use a "follower plate." The use of the "follower plate" will also minimize decanting.

The following tabulation is the result of tests conducted on dispensing equipment at Gray Company office on May 21, 1953.

Test No. 1 (With regular 100-lb. F.R.H. Drum—Virginia Bbl.) Pumping with Standard Graco Dispensing Units—No Adapters.

	No. 2 Lithium Base Multi-Purpose Automotive Grease	*No. 2 Semi-Fluid Aluminum Base Chassis Grease*	*SAE-90 E.P. Hypoid Gear Lubricant*
Pump Model No.	225006-*HP Air* (44-1)	225006-*HP Air* (44-1)	225376-*Manual*
Inches from Bottom	*	*	¼"
Lbs. Product Remaining	29 lbs.	19 lbs.	6 lbs.

*Uneven surface and coning effect makes this measurement meaningless.

This test shows that when using present equipment on the present 100-lb. drum, decanting is necessary long before the depth of the pump suction is reached.

Test No. 2 (With 100-lb. F.R.H. Drum—Virginia Bbl.) Using Graco designed adapter on Dispensing Equipment

	No. 2 Lithium Base Multi-Purpose Automotive Grease	*No. 2 Semi-Fluid Aluminum Base Chassis Grease*	*SAE-90 E.P. Hypoid Gear Lubricant*
Pump Model No.	225006-*HP Air* (44-1)	225006-*HP Air* (44-1)	225376-*Manual*
Inches from Bottom	* 0	*	5/16"
Lbs. Product Remaining	25 lbs.	12 lbs.	2 lbs.

*Uneven surface and coning effect makes this measurement meaningless.

Test No. 3 (With 120-lb. Universal Drum—Simulated) No Adapter

This test suspended since it only shows that an additional amount of grease equal to the increased height of the 120-lb. Universal drum remains after pump suction is lost.

TEST No. 4 (With 120-lb. Universal Drum—Simulated) Using Graco Designed Adapter on Dispensing Equipment

	No. 2 Lithium Base Multi-Purpose Automotive Grease	*No. 2 Semi-Fluid Aluminum Base Chassis Grease*	*SAE-90 E.P. Hypoid Gear Lubricant*
Pump Model No.	Test on Mg. No. 2 sufficiently proves Adapter efficiency	225006-*HP Air* (44-1)	Test on Mg. No. 2 sufficiently proves Adapter efficiency
Inches from Bottom		*	
Lbs. Product Remaining		12 lbs.	

*Uneven surface and coning effect makes this measurement meaningless.

On No. 2 Lithium Base Multi-Purpose Automotive Grease and No. 2 Semi-Fluid Aluminum Base Chassis Grease in every instance it was necessary to paddle the product twice in order to destroy the suction cavity.

Summarizing the results of the test, it is apparent that, at present, all users of heavy type greases start having trouble keeping their grease guns full of grease when approximately ⅔ of the product is out of tha drum. In any case with the equipment used today on the 100-lb. drum from 3" to 5" of product always has to be transferred, consequently, the question of decanting becomes rather academic.

The tests show that the operation of all existing equipment (not now having an adjustable adapter) will be improved and decanting minimized by adding the inexpensive sleeve adapter. If an adapter is added to any existing equipment, this equipment can immediately be used on any 100-lb. or 120-lb. drum regardless of variations in height. In addition, this test points up the fact that all dispensing equipment purchased in the future should be ordered with the specification that they be equipped with this sleeve type adapter.

CAPACITY:

120 lbs. of product net—minimum
Gross volume 16.2 (U.S.) Gal. at 60° F.

GAUGE AND TYPE OF METAL:

20 gauge throughout (U.S. Standard gauge)
Cold Rolled Steel

DIMENSIONS:

Height over-all 25 ¼"

Diameter over-all at rolling hoops 14 7/8"

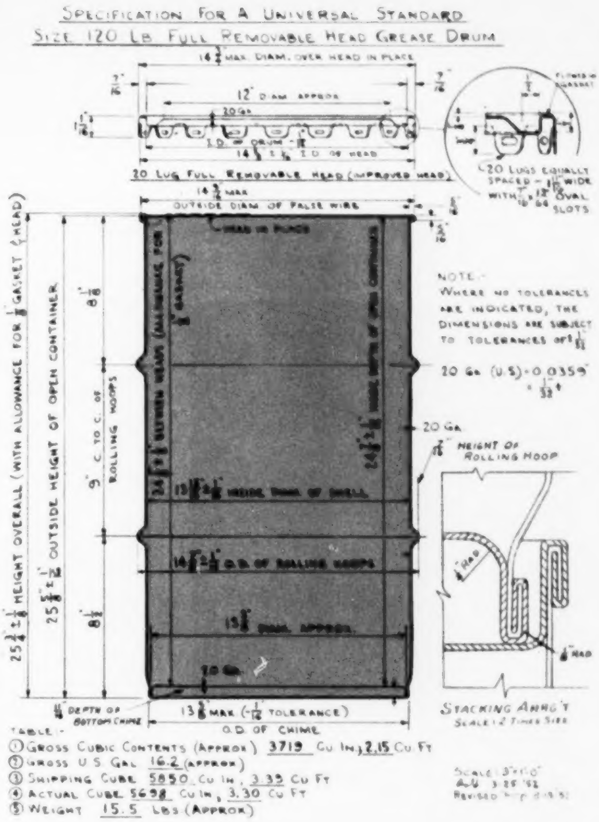
Over-all diameter over false wire 14 9/16" (Maximum)

Over-all diameter of Reduced Section of Bottom 13 5/8" (Maximum)

Average Weight 15.5 lb. (approx.)

Inside diameter of drum shell 13 15/16"

Inside Height between heads 24 7/8"



(Note: Manufacturer's tolerances on all over-all dimensions as specified on drawing.)

COVER:

*Full open cover with 20 lugs 1 11/16" width each. Design as per drawing.

CHIMES:

Top—None—Has a rolled 5/16" false wire
Bottom—reduced section to permit nesting as per drawing.

ROLLING HOOPS:

7/16" deep. Spaced as per customer specifications.

CORRUGATIONS:

None

PLUGS OR BUNGS:

None

PAINTING:

The paint shall be applied to a clean phosphated surface using a good grade of paint in sufficient density to give a complete and opaque coverage. Lithographing if desired.

GASKET:

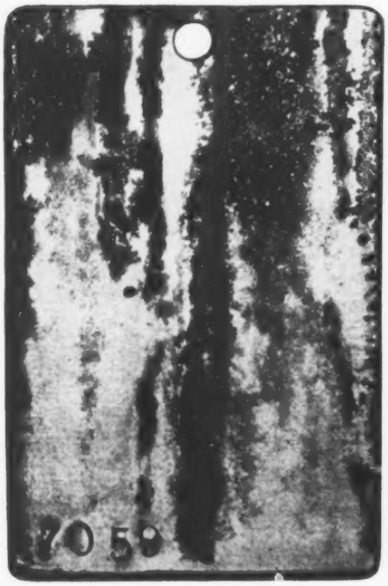
A flowed in gasket uniformly distributed about the circumference of the inner rounded edge of the head. The gasket material is to be of sufficient thickness to provide an adequate seal.

*Rev. 10-22-52 Dimension changed from 1 5/16" to 1 11/16"

1,000-hour test of grease based on

Metasap* Aluminum Stearate

defies rust, corrosion, and damage from salt spray



Rust marks show that grease "A" failed to protect this test panel.

Grease "B" did not prevent this serious rusting and pitting in 1,000 hours.

But Metasap Aluminum Stearate Base grease completely protected this panel

FARM machinery takes some awful punishment from the weather. Especially in salty air along seacoast areas. Probably no more taxing service could be found for a protective lubricant. Yet, a leading nationally-known grease maker found by test how to defend farm machinery from even the most grueling weather conditions.

After coating testing panels with grease based on Metasap Aluminum Stearate and keeping them in humidity and salt spray cabinets for 1,000 hours, he says results convinced him that such a grease is *"head and shoulders above other greases."*

Not only do Metasap Aluminum Stearate greases provide a top-notch protective agent for farm machinery anywhere, but such greases have proved equally superior for tough lubricating jobs in many other arduous services.

Metasap Aluminum Stearate Bases can probably solve a difficult lubricating problem for you. We'll be glad to help you select the correct base for any given oil, to meet your needs. Or achieve any desired effect in a finished grease, through use of proper soap mixtures.

*REG. U.S. PAT. OFF.

METASAP CHEMICAL COMPANY, Harrison, New Jersey

Branches: CHICAGO • BOSTON • CEDARTOWN, GA. • RICHMOND, CALIF.

Stocks at: Cleveland, Ohio; Louisville, Ky.; Los Angeles, Cal.; Portland, Ore.; Spokane and Seattle, Wash

METASAP CHEMICAL COMPANY REG. U.S. PAT. OFF.

Stearates

of Calcium • Aluminum • Lead • Magnesium • Zinc

Technical Committee

Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

Organization of the 1953 Symposium Subcommittee has been completed and the membership is:

J. F. Carter, *Chairman*, The Aro Equipment Corporation
J. W. Basore, Mid-Continent Petroleum Corp.
L. C. Brunstrum, Standard Oil Co. (Indiana)
T. E. DeVilliers, Cities Service Oil Co.
G. H. Link, Shell Oil Company
G. E. Merkle, Fiske Bros. Refining Co.
L. Miller, The Aro Equipment Corporation
C. F. Raisch, Stewart-Warner Corporation
L. C. Rotter, Lincoln Engineering Company
C. E. Watson, California Research Corporation

It is possible that other members will be added in the near future.

Mr. Carter called a meeting of the subcommittee for June 9, in Bryan, Ohio, to plan the program and arrange for speakers.

Two groups have undertaken studies of the compatibility of lubricating greases. The Joint Committee on Lubricating Greases for Railroad Antifriction Journal Bearings is nearing completion of an evaluation of readily available methods for determining the extent of the changes of consistency resultant from admixtures of certain lithium soap greases with predominantly sodium soap greases and vice versa. It is not their present intention to develop new methods. It is hoped that the survey will uncover a procedure which is already available and which will be adequate to take care of current requirements. ASTM Technical Committee G, Section III, is organizing a subsection to evaluate functional type tests for evaluating compatibility. Norman Faust, of The Texas Company, is chairman of that subsection.

Admixture of lubricating greases, deliberate or by error, has long been recognized as a probable source of trouble under service conditions. Technologists responsible for development of products point out that their formulae represent careful balances of components and that their selection of manufacturing conditions is likewise directed to obtain particular structures. The admixture of a different grease, particularly if in a used condition, seldom results in a lucky improved new formulation. Instead, the mixture usually shows performance characteristics at least inferior to the better product of the combination. From the viewpoint of the research staff, there should be no compatibility problem because admixtures of greases should be avoided, particularly when the nature of the grease added may vary over extremely wide limits. The field engineer may have an opposing viewpoint. He may be confronted with many bearings that cannot be cleaned of old grease at a reasonable cost. He may decide therefore that a compromise is necessary. He may recommend that a different product be added to the existing charge, and be willing to accept possibly inferior performance for a period of service.

The adoption of projects by the two aforementioned groups may be taken as evidence that compatibility has acquired increased importance since the advent of lithium soap and other comparatively new thickening agents. Certainly the interest in those projects is widespread. The activities will lead to a better understanding of the practical significance of compatibility regardless of whether a satisfactory method is developed for determining that characteristic.

Patents and Developments

Greases Using Reaction Products of Hydroxy Fatty Acids

According to U. S. Patent 2,628,938, issued to Phillips Petroleum Company, metal salts of the reaction product of a hydroxy fatty acid (particularly alpha hydroxy), and a fatty acid, are excellent grease gelation agents. Those acids which are not, per se, suitable grease gelation agents are claimed to be changed so that they can be used to produce lubricating greases. The reaction product, formed upon esterification of the hydroxy group of the hydroxy fatty acid with one or more molecules of such an acid, when converted to a metal salt, is claimed to be an excellent gelation agent.

The reaction product preferably is made by heating at 150°-225° C. an alpha hydroxy fatty acid (such as alpha hydroxy decanoic acid) with a fatty acid (such as lauric acid) in the liquid phase for a sufficient length of time (1-12 hours) to effect reaction. A condensation catalyst such as zinc chloride may be employed. The product then is neutralized to produce, say the sodium salt, and used in the grease formulation.

In choosing the starting reactants, it is desirable to choose a pair which will yield a juncture product of at least 16 carbon atoms per molecule (perferably 18), disregarding any dimerization which may occur.

By use of these gelation agents, gel-type lubricating greases may be prepared with little or no working to produce a smooth grease with little tendency to bleed.

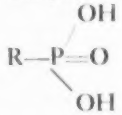
Stabilized Lithium Base Grease

For efficient aircraft operation, greases should have low temperature torque properties such that they will flow properly at temperatures as low as about -70° F. Also, they should be of low volatility and should retain their structure at least at 250° F. Other desirable features include homogeneity, smooth unctuous consistency, and water, oxidation, breakdown and shear resistance.

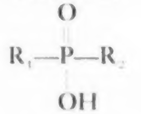
The demand for greases of these specifications is claimed to have not been satisfied to date, except by resort to expensive operating procedures. One difficulty with lithium base greases is poor retention of gel structure at temperatures around 250° F., and poor oxidation stability.

According to U. S. Patent 2,628, 949 issued to Socony-Vacuum Oil Company, lithium base greases containing polybasic acid ester vehicles are greatly improved by incorporation therein of lithium phosphonates or phosphonites having the formula:

Phosphonate



Phosphonite



where R is an aliphatic group having 4-22 carbon atoms per molecule, a monocyclic aryl group, a monocyclic naphthyl group or an alkylated monocyclic naphthyl group. R_1 and R_2 can be the same or different groups taken from the series just given.

Among examples of the compounds suitable for the purpose are mono and di-lithium salts of n-butyl phosphonic acid, eicosanyl phosphonic acid, 2-ethyl hexyl phosphonic acid, tetradecyl phosphonic acid, di(phenyl) phosphinic acid, etc. Their preparation is described in "Organophosphorus Compounds" by G. M. Kosolapoff. They are used in amounts of 0.75-2.5%.

These additives are particularly effective with polyglycol dioctoate (Ucon 818) base greases as well as other blends based on synthetic dibasic organic acid ester-based lithium greases. The lithium soaps comprise 10-17% of the finished greases. It is cautioned, however, that inasmuch as the ester bases are susceptible to saponification, they should not be used in the preparation of the grease until the formation of the lithium soap is complete, if a lithium soap is formed in situ. If they are formed in the diesters, they should be reacted at relatively low temperatures such as 80°-200° F.

Inorganic Colloid-Gelled Greases

Greases made of lubricating oils gelled with inorganic colloids have been described in the Munch German Patent 451,055 and the Kistler U. S. Patent 2,260,625. In most cases, the inorganic agents have been various forms of silica and, due to their ability to maintain structural stability at elevated temperatures, they have been of particular interest for such service. As pointed out previously in this column, their outstanding shortcoming is their sensitiveness to water.

In U. S. Patent 2,629,691 issued to Shell Development Company, the various proposals for overcoming this difficulty are reviewed. According to this patent, the water resistance and other characteristics of such greases are substantially improved when the ingredients are heated for 20-180 minutes at 165°-200° C. This heat treatment is especially effective if a surface-active hydrophobic material useful as a waterproofing agent is present during a substantial part of the heating period. Gelling power of the inorganic colloid is claimed to be improved by such treatment, especially after the colloid material has been treated with 1-30% phosphoric or boric acid previous to incorporation into the grease.

Improved Lithium Greases

In the manufacture of lithium greases such as those based on lithium stearate, the procedure generally involves three stages: (1) Mineral oil and soap are heated together at high temperature to effect dissolution of the soap, (2) the solution is cooled to cause gelation, and (3) the gelled product is homogenized or worked to impart a suitable grease structure. According to U. S. Patent 2,629,695 issued to Shell Development Company, the second step is the really important one in influencing the nature and properties of the finished grease.

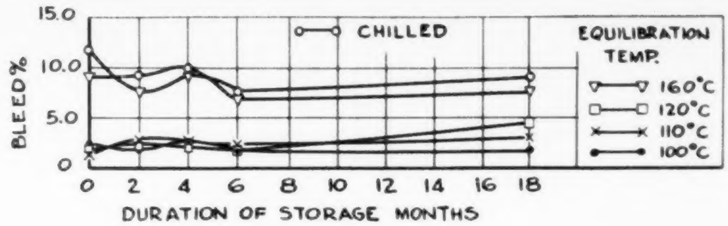


FIG. 1

Advantages claimed to be gained by new process related to effect of storage upon pertinent grease characteristics (See also Fig. 4, next page)

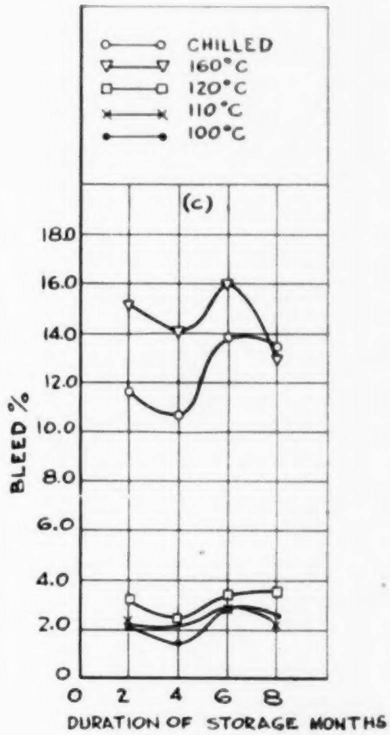


FIG. 2

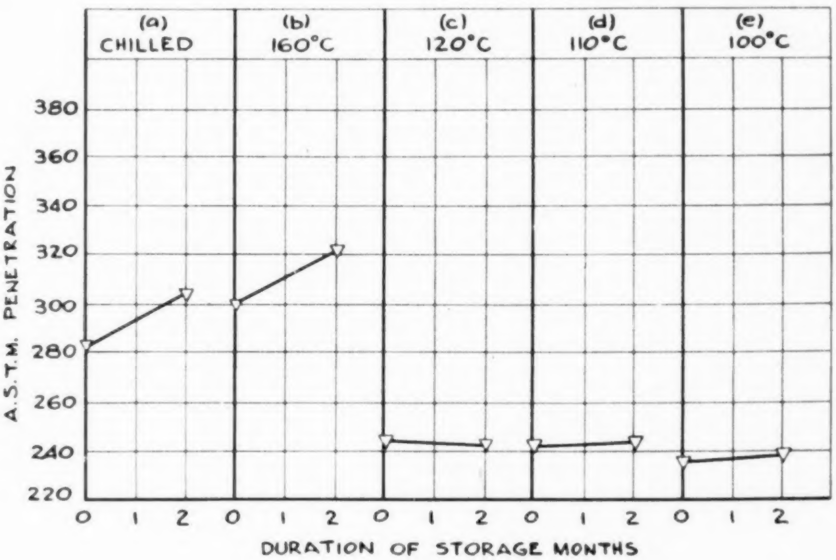


FIG. 3

It is pointed out that the conditions for this second stage of cooling have been largely empirical, often resulting in greases showing a poor yield, tending to bleed in storage, etc. Work on lithium fatty acid soap greases disclosed a series of phase transformations in the oil-soap system, each definable by reference to a different temperature and associated with a change in the condition of the soap phase rather than that of the oil phase. For instance, cooling of a certain grease containing 8.5% lithium stearate from 210° C. to room temperature results in gel formation setting in at about 195° C., but a series of phase transformations can be detected at 196°, 167°, 120° and 94° C. They can be detected by thermal analysis evidenced by the latent heat effect.

As a result of this work, it was discovered that by taking suitable steps to secure that the soap phase assumes the structure which is stable between the two lowest phase transformation points occurring above 50° C., it is possible to secure greases that are markedly superior in stability and have a consistency much superior to those obtained by conventional methods. According to the invention, a grease consisting of an oleaginous vehicle and a lithium soap of a higher fatty acid is made by heating the ingredients until a homogeneous composition is formed, cooling the composition to a temperature which lies between the temperatures of its two lowest phase transformation points which occur above 50° C., isothermally gelling the composition while it is at that temperature, and finally cooling and homogenizing the gel.

The precise temperature at which the composition is isothermally gelled (equilibrium temperature) is not critical provided that the whole of the composition is in the particular condition which is stable between its two lowest phase transformation points occurring above 50° C. To insure that the whole composition is in the desired condition when it is isothermally gelled, it is highly desirable that the rate of cooling to the equilibrium temperature be sufficiently slow (1°-3° C. per min.) to enable the grease to complete the phase transformations occurring at higher temperatures.

The isothermal gelling is accomplished by maintaining it statically or with stirring at an equilibrium temperature for 1-16 hours. If the grease is cooled below the equilibrium temperature before the gelling is complete, the resulting product has a poor yield and poor bleed value.

The usual greases using mineral oil bases generally exhibit two phase transformation points, the lowest above

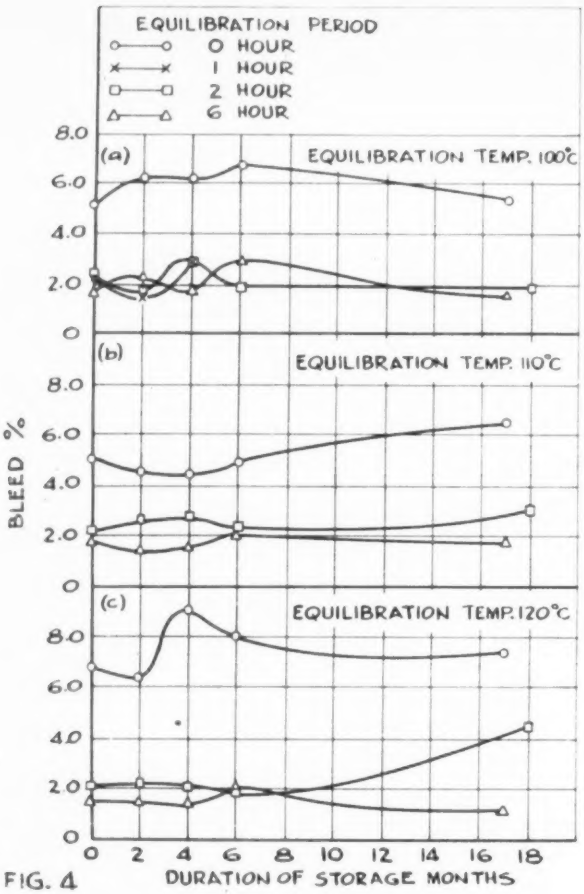


FIG. 4

50° C. being 94° C. and 120° C. The process then involves heating the grease to above 210° for homogenization and then equilibrating it isothermally at between 94° and 120° C.

The greases are cooled at a rapid rate to a temperature of at least 60° C. following the isothermal gelling period (5°-15° per min.).

To illustrate the effect of soaps other than lithium fatty acid soaps upon the critical phase transformation temperatures, Table I presents data on greases made with 8% total lithium soaps as indicated, using a mineral oil base.

Table I

EFFECT OF SOAP COMPOSITION (MIXED) ON PHASE TRANSFORMATION TEMPERATURE

	Two Lowest Critical Phase Transformation Temperatures above 50° C.	
100% stearate	96	120
95% stearate, 5% 12-hydroxy stearate	91	113
90% stearate, 10% 12-hydroxy stearate	91	110
80% stearate, 20% 12-hydroxy stearate	100	108
70% stearate, 30% 12-hydroxy stearate	112	115

The data shown in Figs. 1-4 in graph form show the advantages claimed to be gained by the new process related to the effect of storage upon the pertinent grease characteristics.

News Items

Tests for ball and roller bearing greases—McConville (Product Engrg. 3-53 p. 160).

Mechanical testing of gear lubricants—the (British) Thornton high speed gear rig test technique—Hughes et al (Engineering 2-13-53 p. 200).

An industrial chiller made by Conrad Industrial Coolers, Holland, Mich., for Gulf Research Labs. will be used to test low temperature greases for aircraft. Using Freon 13, it can reduce temperatures from 68° to −100° F. (Air Condg. & Refrig. News 3-16-53 p. 17).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"SIGNAL SAYS TELLUM PALEFACE TO MAKE RESERVATIONS NOW FOR NLGI ANNUAL MEETING AT THE EDGEWATER BEACH HOTEL IN CHICAGO FOR OCTOBER 26-28!"

PEOPLE in the Industry

Ralph O. Rhoades Heads World-Wide Exploration And Production for Gulf Oil

Ralph O. Rhoades, a vice-president of Gulf Oil Corporation since 1951, has been placed in charge of the company's world-wide exploration and production activities, according to an announcement made by S. A. Swensrud, board chairman, and W. K. Whiteford, president.

Mr. Rhoades, a geologist of global experience, succeeds Dr. K. C. Heald, his former chief in the production department, who recently retired. Mr. Rhoades is a Gulf veteran of 27 years.

Born in Henry County, Missouri, Mr. Rhoades' attendance at the University of Kansas was interrupted by World War I. He served as a sergeant in the U. S. Marines in Europe from 1917 to 1919. He then completed studies in geology at Stanford University, receiving his degree in 1922.

He began his career as a geologist with the Companias del A.G.W.I. in Mexico. Next followed work as a free lance geologist in Egypt. Later he engaged in geological activities for an independent operator in Arkansas and Louisiana.

In 1926 Mr. Rhoades joined the Gulf organization and was assigned to its operations in Colombia, South America. A year later he was transferred to the Middle and Far East. Included in his service between 1927 and 1933 were four years in the Dutch East Indies. He was one of the early American geologists to investigate oil properties of the Persian Gulf area, including Bahrein and Kuwait.

In 1933 he was transferred to Pittsburgh as a member of the general office production department geological staff. Two years later, he again traveled abroad to carry out geological investigations in Great Britain, a number of other European countries, and Kuwait.

In the latter country, now the site of one of the world's major oil fields, he became resident geologist during the first year of active operations. Following that he was stationed in London as European Representative of Gulf's Production Department.

Returning to Pittsburgh in 1940, he served as assistant staff geologist until 1948 when he was made chief staff geologist. A year later he was named chief, land and exploration branch, production department. On January 1, 1951, Mr. Rhoades became executive assistant to the head of the company's production department, and in October of that year he was elected a vice-president.

Mr. Rhoades will continue to make his headquarters in Pittsburgh.

Charles W. Grubb Becomes A Witco Sales Manager

Witco Chemical Company has appointed Charles W. Grubb to the position of sales manager for the New England states, with headquarters in Boston.

Mr. Grubb, who has been a salesman in the Boston office for three years, succeeds Goodwin Bangsburg as sales manager. He specialized in business and chemistry at Rutgers and Boston Universities after serving three years in the army ski troops.

Mr. Grubb is a member of the Boston Rubber Group, the Rhode Island Rubber Group and the New England Paint, Varnish and Lacquer Association.

General Mills Appoints Director of Chemical Sales

Abner C. Hopkins, Jr., has been appointed director of chemical sales for the Chemical Division of General Mills, it was announced by Sewall D. Andrews, Jr., general manager of the division.

Mr. Hopkins was formerly director of commercial chemical development at the General Mills research laboratories in Minneapolis, a position he held since joining the company a year ago. Prior to that he worked with various industrial firms in chemical market research and evaluation, cost and economic studies, sales development of new products, research production, and sales administration.

K. C. Heald Retires June 1 As Vice-President, Former Director of Gulf Oil Corp.

K. C. HEALD

Dr. K. C. Heald, vice-president of Gulf Oil Corporation in charge of its world-wide exploration and production activities and a director of the company for a number of years, has announced his retirement from active service June 1. He will continue to carry on certain consulting work.

Recognized as one of the world's most renowned geologists, Dr. Heald is a holder of the Sidney Powers Memorial Medal which was presented to him last year. This is the highest honor bestowed by the American Association of Petroleum Geologists.

Educated at the University of New Mexico, Colorado College, and Yale University, Dr. Heald joined Gulf as chief staff geologist in 1925. He was elected a vice-president in 1945 and placed in charge of the company's exploration and production activities in the United States and Canada.

In 1950, Dr. Heald was elected to the Gulf board and at that time he was made responsible for the company's world-wide exploration and production activities. He also has been a member of the Gulf finance commit-

tee and its budget, expansion, and policy committees.

Dr. Heald's career as a geologist began shortly after his graduation from Colorado College in 1912 when he went to Peru as pathfinder for the expedition headed by Hiram Bingham which uncovered the now famous ruined city of Machu Picchu and visited the lost city of Choquequirau, neither of which had ever been found by the Spanish invaders under Pizzaro.

In 1914, following graduate work at Yale University, Dr. Heald became a regular member of the United States Geological Survey, a governmental agency that had employed him in temporary positions while he was still a student at Colorado College.

In 1917, the Survey placed him in charge of a group to map structures and seek likely oil sources in the Osage Indian Reservation. The work of this group is considered one of the outstanding geologic accomplishments of history, for within five years of the completion of the survey oil was discovered on 48 of the mapped structures.

In 1920, Dr. Heald was appointed acting chief of the Oil and Gas Section of the United States Geological Survey, and two years later he was made chief of that section. In 1924, he was appointed an Associate Professor of Geology at Yale University, a position he resigned a year later to join Gulf.

Dr. Heald has been a member of the National Research Council and was chairman of the Committee on Studies in Petroleum Geology from 1923 to 1930 for the council. He is also a member of the Geological Society of America, the American Association of Petroleum Geologists, and many other technical and scientific organizations.

Robert I. Wishnick Given IIT Service Award

Robert I. Wishnick, president of Witco Chemical Company and a trustee of Illinois Institute of Technology, was presented the Service Award at the recent Annual Alumni Reunion Dinner for his work as an alumnus in the interest of IIT.

Mr. Wishnick, a founder of the Alumni Fund, has served continually on the Special Gift Committee of the Fund, and has served as an alumni counselor on the New Student program.

Deep Rock Promotes Sullivan To Manager, Lube Oil Sales

L. H. Sullivan has been promoted to manager of Deep Rock Oil Corporation's lubricating oil sales department, it was announced by W. M. Murray, manager of the general products sales department.

Mr. Sullivan has been with Deep Rock since 1937 except for two years spent in the Navy during World War II. During this time, he has been with Mr. Murray five years in the Chicago and Tulsa offices.

In announcing the promotion, Mr. Murray commended Mr. Sullivan for his highly successful work in Deep Rock sales over the years.

C. E. Hulme Named NLGI Representative of Kendall

Cedric F. Hulme has been appointed Kendall Refining Company representative to the National Lubricating Grease Institute. Mr. Hulme replaces Dr. R. K. Smith who recently resigned from Kendall to accept a position with the Houdry Process Corporation.

C. E. HULME

Mr. Hulme has had experience in the manufacture and evaluation of greases. During his 28 years of association with Kendall, Mr. Hulme has had an important role in the development of the greases currently in the Kendall line. He is a member of his company's quality control committee concerned with the specification and production of all lubricants.

Currently, Mr. Hulme is Kendall's manager of sales engineering. Prior to assuming that position he held the position of chief control chemist. He has been active on various A.S.T.M. and S.A.E. committees and has represented his company in the various activities of C.R.C., N.P.A. and A.P.I.

ASTM Presents Awards At 56th Annual Meeting

Ten technical leaders in the field of engineering materials—men who have rendered outstanding service to the American Society for Testing Materials, particularly in its technical committee work—were honored during the ASTM 56th Annual Meeting in Atlantic City the week of June 29 when they received Awards of Merit.

The following men received 1953 Awards of Merit:

F. G. Ham, Technical Director, John A. Manning Paper Co., Troy, N. Y.

J. T. MacKenzie, Technical Director, American Cast Iron Pipe Co., Birmingham, Ala.

D. G. Miller, Materials Engineer (Retired), Bureau of Public Roads, U. S. Department of Commerce, University of Minnesota, St. Paul, Minn.

R. E. Peterson, Manager, Mechanics Division, Westinghouse Research Laboratories, Westinghouse Electric

Corp., East Pittsburgh, Pa.

C. H. Rose, Manager of the Washington (D.C.) Office of the National Lead Co.

W. A. Selvig, Senior Chemist, U. S. Bureau of Mines, Pittsburgh, Pa.

E. I. Shobert II, Manager, Research and Engineering, Carbon Division, Stackpole Carbon Co., St. Marys, Pa.

E. R. Stivers, Director, Package Research Laboratory, Rockaway, N. J.

Jerome Strauss, Vice-President, Vanadium Corporation of America, New York, N. Y.

R. B. Young, Associate Director of Research, The Hydro-Electric Power Commission of Ontario, Canada.

Citations for the ten men receiving the 1953 ASTM Awards of Merit are as follows:

Authors of outstanding technical papers presented at previous meetings of the American Society for Testing Materials received awards at the ASTM 56th Annual Meeting in Atlantic City during the week of June 29 as follows:

Charles B. Dudley Medal—To Evan A. Davis and Michael J. Manjoine, Research Engineers, Westinghouse Research Labs., Westinghouse Electric Corporation, East Pittsburgh, Pa., for their paper entitled "Effect of Notch Geometry on Rupture Strength at Elevated Temperatures" presented at the 1952 50th Anniversary Meeting. This medal is presented for a paper of outstanding merit constituting an original contribution on research in engineering materials.

Richard L. Templin Award—To William N. Findley and P. G. Jones, Research Associate Professor, and Associate Professor, Theoretical and Applied Mechanics, respectively, University of Illinois, Urbana, Ill., Robert L. Sutherland, Associate Professor of Mechanical Engineering, State University of Iowa, Iowa City, Iowa, and Professor W. I. Mitchell, South Dakota School of Mines, Rapid City, South Dakota, for their paper "Fatigue Machines for Low Temperatures and for Miniature Specimens" presented at the 1952 50th Anniversary Meeting. This award is presented for a paper describing new testing methods and apparatus, the purpose of the award being to stimulate research in the development of testing methods and apparatus.

Sanford E. Thompson Award—To Katharine Mather, Chief, Petrography Section, Concrete Research Div., Waterways Experiment Station, Corps of Engineers, Jackson, Miss., for her paper "Applications of Light Microscopy in Concrete Research" presented at the 1952 50th Anniversary Meeting. This award is given for a paper of outstanding merit on concrete and concrete aggregates.

Sam Tour Award—To J. R. McDowell, Research Engineer in Mechanics Dept., Westinghouse Research Labs., Westinghouse Electric Corporation, East Pittsburgh, Pa., for his paper entitled "Fretting Corrosion Tendencies of Several Combinations of Materials" presented at the 1952 50th Anniversary Meeting. This award is given for a paper on corrosion testing, the purpose of the award being to encourage research on the improvements and evaluation of corrosion testing methods.

Industry NEWS

Gre-Zer-Ator Incorporates Idea for Greater Lubrication

Welcomed news to dealers and to operators who are interested in lubrication is the Reversabout Booster featured on the new Gre-Zer-Ator, portable greasing gun manufactured by National Sales, Inc., 812 North Main, Wichita, Kansas.

The Reversabout Booster is a new idea for convenience in lubrication, allowing the operator to use either a push or pull action on the handle. It can be set either way in a few seconds time. If working space is available, then booster handle can be placed in a push position to allow a greater amount of grease to be dispensed. The Reversabout Booster is simple to clean, easy to repair, and is finely constructed of top grade steel.

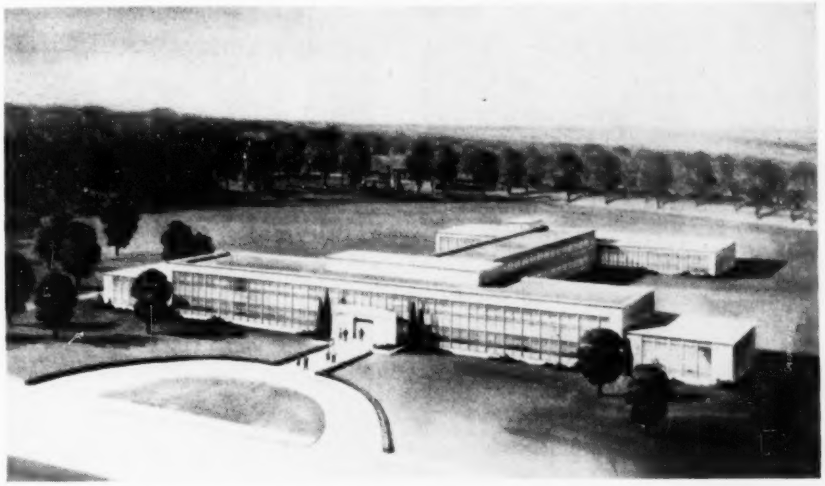
The Gre-Zer-Ator was the original one man, one hand, high pressure grease gun made for an original refinery container. It operates without air or electrical connections, it's easy to move, and yet the hydraulic booster will readily develop to 7000 lbs. of pressure. the new Gre-Zer-Ator is equipped with 10 feet of hose with swivel connection to prevent kinking.

Equipped with the new small diameter hydraulic "Contacto" Coupler, the Gre-Zer-Ator can lubricate even the most hard-to-reach fitting instantly. Just one or two squeezes of the power-packed pressure booster will service the average bearing, and one charge of the pump assembly will supply enough lubricating grease for more than 200 bearings.

With a rust resistant finish of attractive zinolyte, the Gre-Zer-Ator has all-steel construction to assure extra years of service. It is equipped with a vivid red-orange steel cover which features a full, flat surface for ample foot room.

Although the price of Gre-Zer-Ator is very low, it gives service station performance in field use to any operator, making the Gre-Zer-Ator a fast selling item.

Midwest Research Plans New Two-Story Building



Construction of a new scientific center for the Midwest Research Institute will begin in Kansas City, Mo., in October. All operations of the institute will be consolidated in the structure. The new building, to be built on a nine-acre tract will include 71,000 square feet of floor space.

A functional two-story laboratory and headquarters structure, planned to provide maximum area for tasks of scientific inquiry as well as space for future expansion, is planned for construction soon by the Midwest Research Institute in Kansas City.

The new building will contain 71,000 square feet of floor area and will be located on a 9-acre plot in the cultural center of Kansas City, adjacent to the Linda Hall Library of Science and Technology.

Construction will start in the fall, probably October, on the building, planned to cost 1¼ million dollars. All operations of Midwest will be consolidated in the structure. The institute now occupies six scattered buildings.

Organized nine years ago to serve as a technological and research center for the Middlewestern states, Midwest Research Institute now carries on projects for sponsors and clients throughout the nation. Its annual research volume is in excess of 1 million dollars. It has served some 460 sponsors and has undertaken more than 1000 separate projects.

A start on construction of the new building, which was unanimously approved this week by the institute's board of governors, has been made possible because of the enthusiastic support the institute has received from the vast area which it serves, Dr. Charles N. Kimball, president, said.

Businesses throughout the Midwest responded eagerly to a fund-raising campaign for the new building.

The structure will enable Midwest Research, which has developed rapidly within the past few years, to continue expansion of its activities, Dr. Kimball said. The institute expects to continue projects designed to improve the general welfare of the entire Midwestern area, such as study of grain storage problems and industrial development, as well as continuing its numerous research assignments for individual sponsors.

Among special services now being developed is an electronic computer center, which will house both digital and analogue devices to be employed by business and industrial organizations for solution of special computational problems.

ADM President Announces Availability of New Group Of Basic Chemicals in 1954

A new group of basic chemicals will be made available to the chemical industry in 1954 according to Thomas L. Daniels, president of Archer-Daniels-Midland Company. The new products which will consist of unsaturated higher alcohols will be produced at a new chemical plant located at Ashtabula, Ohio, 55 miles northeast of Cleveland on Lake Erie. Ground for the new plant will be broken in June, 1953, and production of both saturated and unsaturated alcohols is expected twelve months later.

According to Mr. Daniels many of the alcohols which will be made at the new plant are not commercially available today. Vegetable, animal and marine fats and oils will serve as the principal raw materials.

The new alcohols which promise many advantages over those now commercially available are expected to find a ready market in new types of detergents because of improved properties and higher purity. They will be used in countless other products including vinyl plasticizers, shampoos, lubricating oil additives, corrosion inhibitors, anti-foam agents, peptizers for synthetic rubber cosmetics, pharmaceuticals, anti-oxidants, agricultural chemicals, synthetic waxes and textile finishes.

While the production of the new unsaturated higher alcohols will be a new venture for ADM, the company has been manufacturing fatty alcohols and glycerides since 1936.

Paper on Greases Made Available by U.S.N.R.L.

Synthetic Low Temperature Greases from Aliphatic Diesters, by G. M. Hain, D. T. Jones, R. L. Merker, and W. A. Zisman. U. S. Naval Research Laboratory. Feb. 1946. 37 p drawings, graphs, tables Microfilm $2.25, Photostat $5.00

A series of low temperature greases has been prepared from the aliphatic diesters thickened with lithium stearate and modified by the addition of small quantities of well-defined chemicals. The syntheses and properties of these diesters have been described in other publications of this Laboratory. The base fluids used in these greases varied in viscosity from 4.6 to 47.3 centistokes at 100° F., and the freezing and pour points varied from below -100 to -40° F. The resultant greases resemble in texture and working properties the present petroleum base greases specified by Army and Navy Specifications An-G3a, AXS-637 and OS-1350. However, the evaporation rates normally encountered in low temperature greases have been eliminated without sacrificing any operating characteristics. Using the lower viscosity diesters, greases have been prepared with lower plasticity numbers (a measure of low temperature torque) at -90° F. than any other product submitted to the Navy for test. Salt spray corrosion protection with the new greases is not yet quite as satisfactory as for the best greases submitted under Navy Specification OS-1350. However, the protection afforded has been found ample for the lubrication of naval equipment not operated openly exposed to salt water spray. These synthetic greases can be processed in standard equipment. So many urgent military needs were found for these greases that, at the request of both the Bureau of Ordnance and the Bureau of Aeronautics, no extensive mechanical or service simulating testing program was attempted by this Laboratory. Samples were distributed to a large number of naval activities and contractors for testing the equipment in which it was to be used.

Facts About Oil Imports Has Just Been Published

Standard Oil Company (New Jersey) has just completed a study of oil imports into the United States. The results of the study and views of the company have been published in a new booklet.

In view of current discussions of this subject, it has been published in the interest of a wider understanding of an important matter.

If you want to receive a copy, send your request to: Standard Oil Company (New Jersey), Room 1626, 30 Rockefeller Plaza, New York 20, New York.

FUTURE MEETINGS of the Industry

JULY, 1953

19-21 Louisiana Oil Marketers Assn. (annual meeting), Jung Hotel, New Orleans, La.

AUGUST, 1953

14 Florida Petroleum Marketers Assn., Sheraton Plaza Hotel, Daytona Beach, Fla.

17-19 Society of Automotive Engineers (international West Coast meeting), Georgia Hotel, Vancouver, B. C., Canada.

18-21 National Congress of Petroleum Retailers, William Penn Hotel, Pittsburgh, Pa.

SEPTEMBER, 1953

6-11 American Chemical Society (124th national meeting), Conrad Hilton Hotel, Chicago, Ill.

9-11 Oil Industry Information Committee, Cleveland Hotel, Cleveland, Ohio.

13-16 American Inst. of Chemical Engineers, Fairmont and Mark Hopkins Hotels, San Francisco, Calif.

14-17 Society of Automotive Engineers (national tractor meeting and production forum), Schroeder Hotel, Milwaukee, Wis.

15-16 American Petroleum Institute (executive committee), Greenbrier Hotel, White Sulphur Springs, W. Va.

16 American Petroleum Institute (Division of Marketing, Lubrication Committee meeting), The Traymore, Atlantic City, N. J.

16-18 National Petroleum Assn. (51st annual meeting), The Traymore, Atlantic City, N. J.

21-23 American Trade Assn. Executives (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

24-25 Western Petroleum Refiners Assn. (regional meeting), Henning Hotel, Casper, Wyo.

27-29 National Assn. of Oil Equipment Jobbers (annual meeting), Neil House, Columbus, Ohio.

27 to Oct. 2 American Society for Testing Materials (Committee D-2 on Petroleum Products and Lubricants), Shoreham Hotel, Washington, D. C.

29 to Oct. 3 Society of Automotive Engineers (national aeronautic meeting), Statler Hotel, Los Angeles, Calif.

OCTOBER, 1953

4-6 American Assn. of Oilwell Drilling Contractors, Denver, Colo.

5-7 Texas Mid-Continent Oil and Gas Assn. (34th annual meeting), Rice Hotel, Houston, Texas.

7-9 National Assn. of Corrosion Engineers, South Central Region (annual meeting), Mayo Hotel, Tulsa, Okla.

8 Virginia Oil Jobbers Assn. (fall convention), Roanoke Hotel, Roanoke, Va.

9 Virginia Oil Men's Assn. (fall convention), Roanoke Hotel, Roanoke, Va.

11-17 Oil Progress Week.

14-15 Indiana Independent Petroleum Assn. (fall convention), Severin Hotel, Indianapolis, Ind.

15-16 Petroleum Marketers Assn. of Texas (annual meeting), Adolphus Hotel, Dallas Texas.

19-20 Independent Petroleum Assn. of America (annual meeting), Texas Hotel, Ft. Worth, Texas.

19-23 National Safety Council, Conrad Hilton, Congress, Morrison, Sheraton, Chicago, Ill.

22-23 Western Petroleum Refiners Assn. (regional meeting), Garrett Hotel, Eldorado, Ark.

25-27 Pennsylvania Petroleum Assn. (fall convention), Pocono Manor, Pocono Manor, Pa.

26-28 National Lubricating Grease Institute (21st annual meeting), Edgewater Beach Hotel, Chicago, Ill.

28-29 Independent Oil Compounders Assn. (6th annual meeting), Edgewater Beach Hotel, Chicago, Ill.

29-30 Society of Automotive Engineers (international production meeting), Royal York Hotel, Toronto, Ontario, Canada.

NOVEMBER, 1953

2-4 Society of Automotive Engineers (national transportation meeting), Conrad Hilton Hotel, Chicago, Ill.

2-4 American Oil Chemists' Socy. (27th fall meeting), Sherman Hotel, Chicago, Ill.

3-4 Society of Automotive Engineers (national diesel engine meeting), Conrad Hilton Hotel, Chicago, Ill.

4-5 Nebraska Petroleum Marketers (annual convention), Paxton Hotel, Omaha, Nebr.

NOVEMBER, 1953

5-6 Society of Automotive Engineers (national fuels and lubricants meeting), Conrad Hilton Hotel, Chicago, Ill.

9-11 The Geological Society of America (annual meeting), Royal York Hotel, Toronto, Ontario, Canada.

9-12 American Petroleum Institute (33rd annual meeting), Conrad Hilton Hotel and Palmer House, Chicago, Ill.

29-Dec. 4 American Society of Chemical Engineers (annual meeting), Statler Hotel, New York, N. Y.

30 to Dec. 5 Twenty-fourth Exposition of Chemical Industries, Grand Central Palace, New York, N.Y.

DECEMBER, 1953

13-16 American Inst. of Chemical Engineers (annual meeting), Jefferson Hotel, St. Louis, Mo.

JANUARY, 1954

11-15 Society of Automotive Engineers (annual meeting and engineering display), Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

FEBRUARY, 1954

8-9 Missouri Petroleum Assn. (annual convention), Chase Hotel, St. Louis, Mo.

8-10 Missouri Petroleum Assn. (annual convention), Chase Hotel, St. Louis, Mo.

15-17 American Petroleum Institute (Lubrication Committee), Sheraton-Cadillac Hotel, Detroit, Mich.

17-18 Iowa Independent Oil Jobbers Assn., Fort Des Moines Hotel, Des Moines, Iowa.

MARCH, 1954

1-5 American Society for Testing Materials (spring meeting), Shoreham Hotel, Washington, D. C.

2-4 Society of Automotive Engineers (national passenger car, body, and materials meeting), Hotel Statler, Detroit, Michigan.

3-5 American Petroleum Institute (Division of Production, Southwestern District), Rice Hotel, Houston, Tex.

8-10 American Inst. of Chemical Engineers, Statler Hotel, Washington, D. C.